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A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. VIII. NEW YORK, AUGUST, 1903. No. 6.

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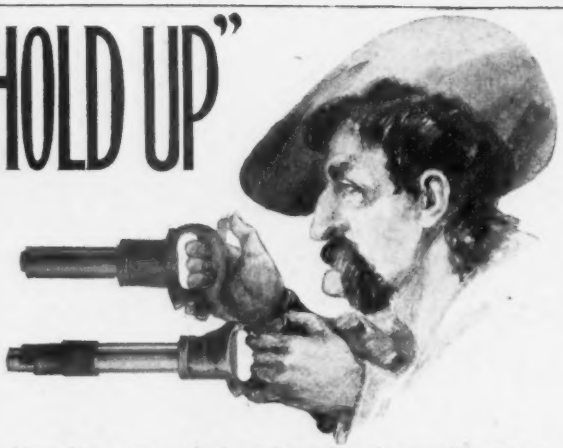

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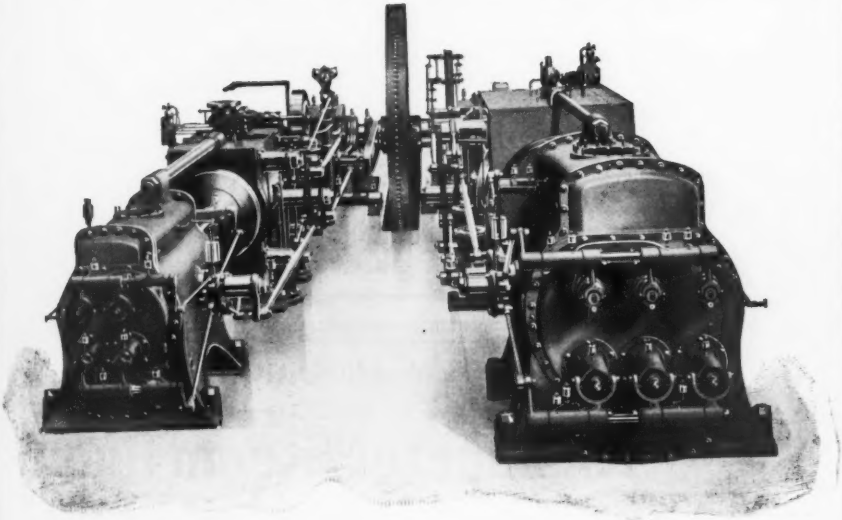

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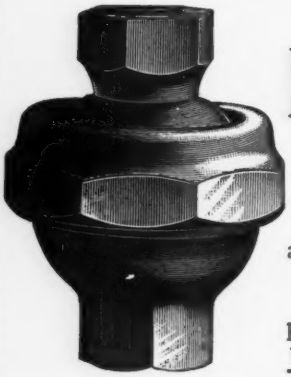

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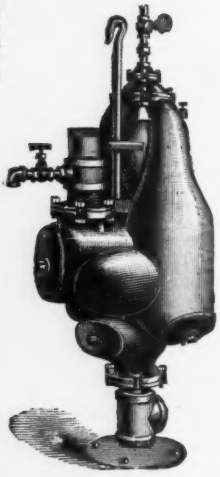

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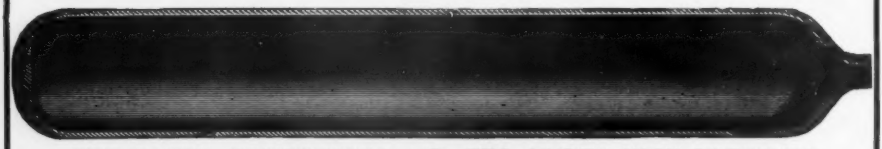

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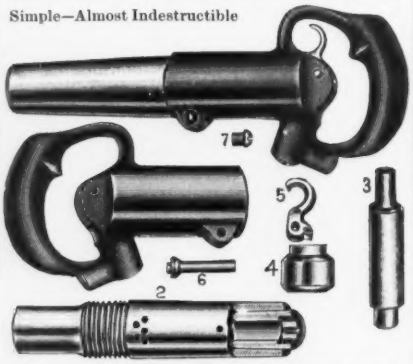

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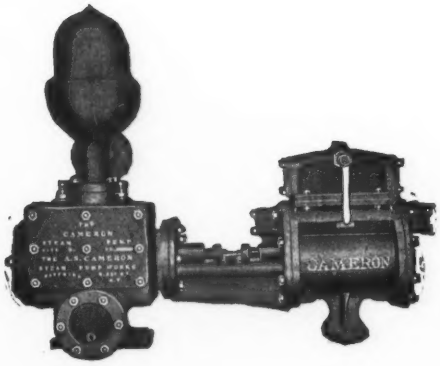

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VOL. VIII. AUGUST, 1903. NO. 6

Publicity for Compressed Air.

It is probable that the people of New York have had the practical value of compressed air from a mechanical point of view brought home to them with more force than ever before since the work on the Subway has been in progress. Hardly a contractor employed on this great underground railway has not utilized this form of power transmission to a considerable extent. Rock drills have been a common sight, while pumps, hoists, tools and a host of other practical applications of air under compression were commonly noted.

In two ways has this been of great value to the manufacturers of compressed air machinery. There is probably no other engineering work of the present decade which has been so eagerly watched by the engineer, who has sought to learn how the many problems inevitable in such an undertaking have been solved. Compressed air has figured prominently, and its varied and successful uses are going to result in its extensive adoption on other public works, where it has heretofore figured but little. Then, too, the public at large has unknowingly been coming to a realization of the importance of compressed air in undertakings of that nature. While it is undoubtedly true that the public will have little to say as to the methods employed, depending on the expert engineers for such details, yet the more the people know of the importance of compressed air in industrial work the greater will its sphere extend.

Because air is such a commonplace thing, always with us, unseen and yet powerful, the unthinking man forgets what an important factor it is. Electricity, on the contrary, is frequently displayed in almost overwhelming fashion. What is more impressive than a severe summer shower with its accompanying electrical display? It is to be expected that the more demonstrative force should acquire a greater place in the public eye. One imagines all sorts of wonderful things of it, while the latent power of the air around us is forgotten. Even when the air itself, rushing along at great speed, carries danger and destruction in its path, many are accustomed to think of what they call wind rather than the air as the all powerful factor. It requires, therefore, some vast undertaking like the New York Subway to bring home to the people the mechanical value and practical application of the air we breathe.

Compressed air machinery has been steadily gaining ground, as has been shown in the issues of this publication, and the future will see it used even more generally than now. Nevertheless, such publicity is going to materially assist in hastening that progress.

Accidents to Air Compressors.

It sometimes happens that one of our good friends points out to us an account of an accident at a compressor plant in which the compressor itself is, according to published prints, responsible. Without in any way throwing discredit on the daily newspapers of the country, we must contend that almost without exception these accounts are woefully inaccurate and place the blame on the compressor, where it does not belong. The reason for these errors is generally lack of information or knowledge of the true cause.

There are cases where false ideas of economy have led to the use of cheap lubricating oils, the deposit from which is inevitably injurious and may be the cause of an explosion. Much more often, however, some gross carelessness is responsible for the accident. Like every other machine, the compressor must be cared for and well treated and will prove harmless as long as it receives proper attention. It will, as well as any other mechanism, attain dangerous possibilities if neglected. The compressor is a valuable machine and needs even more careful attention than a steam engine. Air discharge valves should be looked into regularly once a week. Because with proper care a compressor will behave so well, there are some who have acquired the mistaken idea that it can be left to itself. It is true there are few machines that cause as little trouble as an air compressor if given proper and regular care, so it is particularly important that the attention be given at the right time and in the right way and the efficiency of the machine kept unimpaired. If this course was more generally followed, accidents with compressors would be a rare occurrence.

Air vs. Electric Hoists.

An inquiry has come to us from one of our friends for some accurate data showing the comparative merits of compressed air and electric hoists. As far as we know, nothing on the subject of an exhaustive nature has ever been published. Compressed air and electricity have figured in many a controversy, but these really allied powers have hitherto confined their comparisons to other fields. While the circumstances under which they are called upon to operate may make a vast difference in the relative merits, we are confident that in the long run the advantage lies with the compressed air hoists; provided, of course, that a good reheater is used. The air hoist has always the benefit of simplicity in construction, identical with the best steam practice, for an air hoist is little more than a steam hoist with air as the motive power.

For the benefit of our correspondent and for our readers as well, we shall be glad to publish any letters on the subject which may tend to throw some light on the question of the relative merits of the two classes of hoists.

Electro-Pneumatic Switches.

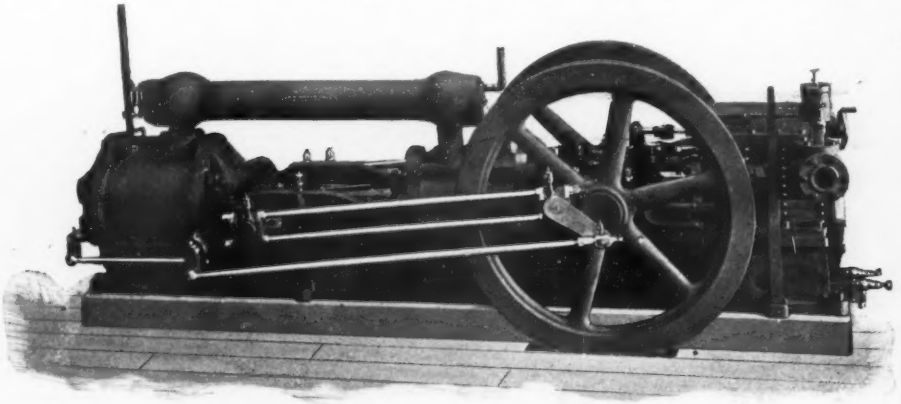
While the electro-pneumatic block system has been in operation on the Central Railroad of New Jersey for over thirteen years, the first power operated plant of interlocking switches has just been installed at the West Eighth street yard, Bayonne, of that railroad. The system in question governs the main line switches and those connecting with the freight yard and freight lines to Port Johnston, the yard at this point being one for receiving coal trains for Port Johnston.

The plant, which has been installed by the Union Switch and Signal Company, of Pittsburg, Pa., is one of that company's latest improved type. The construction throughout is of the most sta-

ble kind, with iron signal poles having internal connections for operating the semaphor arm poles, mounted on concrete foundations, galvanized piping and other details of the modern interlocking system. While the interlocking switches are not new on the Jersey Central, they have been heretofore operated by hand from the signal tower. This new plant substitutes compressed air controlled by electricity for hand power. Both switches and the accompanying signals are operated by air at 65 pounds pressure per square inch, taken from the two-inch main air line which runs from Jersey City to Bound Brook to operate the automatic block signal already mentioned. This line is supplied from three compressing plants, which are located at Jersey City, Roselle and Greenbrook.

This interlocking system in the West Eighth street yard includes one tower where the switches are manipulated. The machine in the tower contains eight levers for the operation of 20 switches and three sets of movable joint frogs. Then there are five levers for the operation of 15 signals, making a total of 13 operating levers. In addition, there are ten spare levers, so that considerable additions to the plant may be made at any time without having to enlarge the machine.

The air cylinders for operating the movable joint frogs are 8 x 7½ inches stroke; those for single switches, 8 x 6½ inches, and those for the signals, 3 x 3½ inches stroke. The operation of the cylinders is, of course, controlled in the usual way in plants of this kind through the medium of electro-magnet valves, operated from the machine. The supply of electric current for operating all the circuits through the interlocking machine, necessary for this control, is secured from a gravity battery in the tower, consisting of four series of 16 cells each, arranged in series. All main line signals at this point assume a danger position when trains pass through on the track which they govern, signals being made semi-automatic in their control through the medium of track circuits, so that there is no interruption at this plant of the electro-pneumatic automatic block signal system. These signals differ from the purely automatic, inasmuch as they are interlocked with the switches and are controlled in the interlocking tower. Upon their assuming the danger position on the passage of a train, they will remain so until the train passes out of the block section controlling it, thus preventing the display of a clear signal by the operator. One train following another waits until the first train has cleared the block beyond the interlocking point. This plant, in the design of apparatus, is similar to that installed at the Boston Southern Station some few years ago. It also corresponds to the three large plants re-

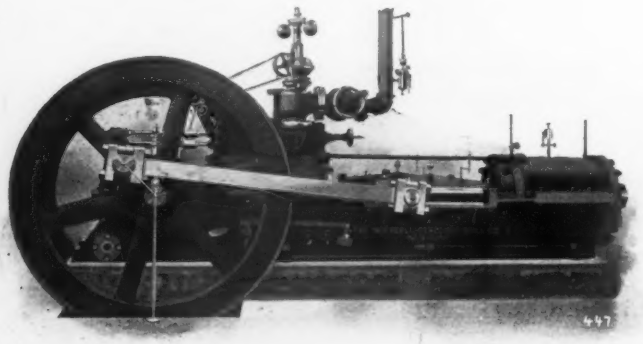


NORWALK COMPRESSOR USED BY CENTRAL RAILROAD OF NEW JERSEY.

cently installed at the new Albany station on the N. Y. C. and H. R. R. R., the Auburn branch of the West Shore and the connection with the main line at Syracuse Junction.

Mention has already been made of the electro-pneumatic block signal system. It was put into operation over a part of the road in 1890, and was extended January, 1893, to Bound Brook, where the four tracks of the Central end. This system is a very simple one, and is operated with much success. In the few wrecks that have occurred on that line, it has been subsequently proven that the signal system was not at fault, and that the blame for the accident rested elsewhere. The signal towers are at varying distances apart, usually not more than half a mile, and sometimes much less. There are two semaphores for each track, one showing the danger signal when the block in front is occupied, and the other serving as a cautionary signal to show that the second block in advance has not been vacated. They receive air pressure for operating from the main pipe line already referred to, the cylinders being controlled through the medium of electro-magnet valves, which in turn are controlled in the usual way from track circuits.

Three compressing plants, located respectively at Jersey City, Roselle and Greenbrook, keep the pipe line fully supplied with air. At the Jersey City station are two compressors, which not only are utilized for furnishing air for the block signals, but supply a certain amount of compressed air for shop use. One of the machines is an Ingersoll–Sergeant straight line Class "A" compressor, with air cylinder 16¼ x 18 inches and steam cylinder 16 x 18 inches, which supplies 518 cubic feet free air per minute, and requires a boiler of 70 horse-power. The exhaust steam is also used to operate one of the boiler injectors in connection with a quarter-inch pipe from the boiler. The compressor discharges through a 4-inch pipe into six reservoirs, 30 x 36 inches inside measurement, the six being connected in series with 3-inch pipe. There is also one Norwalk straight line air compressor which is used for block signals and shop use. It has air cylinders 10 and 6¾ x 12 inches, and a steam cylinder 10 x 12 inches. Its capacity is 207 cubic feet of free air per minute, requiring 28 boiler horse-power. It discharges through a 2-inch pipe into the reservoirs.



INGERSOLL–SERGEANT COMPRESSOR USED BY CENTRAL RAILROAD OF NEW JERSEY.

At the Roselle power plant there is another Norwalk straight line compressor, with air cylinders 14 and 9½ x 16 inches, and steam cylinder 14 x 16 inches. Its capacity is 427 cubic feet of free air per minute, and it uses a boiler horse-power of 28. The pipe from the compressor is four inches, which is reduced to three, leading to the reservoirs. There are six of these similar to the ones at Jersey City. Of that number three

are connected in series next to the power house, which are in turn connected with the other three on the other side of the railroad tracks.

The equipment on the Greenbrook power house consists of an Ingersoll-Sergeant straight line Class A compressor with air cylinder 14¼ x 18 inches, and steam cylinder 14 x 18 inches. This supplies 398 cubic feet of free air per minute and requires 55 horse-power of boiler. A 3-inch pipe leads to the six reservoirs similar to those at the other stations which are connected in series with 3-inch pipe.

We are indebted to Chief Engineer J. O. Osgood and Superintendent of Motive Power W. McIntosh, of the Jersey Central, and to General Manager J. G. Prout, of the Union Switch and Signal Company, for material in preparing the article.

The Air Turbine.

While the steam turbine has already demonstrated its usefulness and economy, the application of the same principle for compressing air is new. In *Cassier's Magazine* for May, 1903, there is a brief mention made of the subject. It is said that an important discovery has lately been made in the form of the blades, which enables this principle to be used with success for the air compressor, the original steam turbine or other high speed machine being coupled direct to the air turbine. The air turbine is very similar to the steam turbine, which usually consists of alternate rows of moving blades and guide blades and is driven at a high speed. Each row of blades increases the pressure and gives a perfectly steady blast. In the article mentioned it relates that such a plant, installed for a lead works on the Tyne, supplied 3,500 cubic feet of air per minute, at 4 inches mercury pressure. It is said when this plant is set to work an increase of 30 per cent. was noticed to the output of the furnace, due, apparently, to the steadiness of the blast.

Cassier's Magazine further tells of the furnace engine now running at the Barnley Iron Works, New Leeds, London, which consists of a steam turbine running at 5,200 revolutions per minute driving the air turbine. The output is rated at 11,300 cubic feet of free air per minute, at three pounds pressure. The power in the useful output of air was found to be 61 per cent. of that theoretically obtainable from the same amount of steam used in the theoretically perfect engine, between the same limits of temperature.

It is explained that in all these plants no air valves are required as the moving vanes maintain the pressure of the blast so that, as in the case of the original steam turbine, the repairs are practically nil and the efficiency of the plant will be maintained indefinitely. When an increased pressure is required to clear the furnace, it is possible to increase the speed of the steam turbine by opening a bye-pass admitting high pressure steam to the low pressure part of the cylinder, and the pressure given by the air turbine is thus increased in proportion.

A high pressure two-stage air compressor on the turbine principle is reported as now being constructed for the George Goch mine, at Johannesburg, South Africa. It is fitted with condenser, pumps and intermediate cooler, and is designed for an output of 4,000 cubic feet of free air per minute, at 80 pounds pressure.

Air Lift Plant at the San Antonio Abad Cotton Mills in the City of Mexico.

A mistaken idea prevails among many that the people of Mexico are not taking advantage of the latest mechanical contrivances. An excellent illustration of an up-to-date plant recently installed is that of the air lift plant which has just been started for the San Antonio Abad Cotton Mills, an entirely Mexican concern, located in the City of Mexico.

There are two artesian wells supplying water for the boilers and for the various processes of manufacture. Well No. 1 is 590 feet deep and cased to the bottom with 5-inch pipe. Well No. 2 is 459 feet deep and cased to the bottom with 4-inch pipe. The water is raised to two iron tanks on the roof of the building, the combined capacity of which is 50,000 litres or about 13,200 gallons. The discharge into these tanks is 28 feet above the ground. The water level in the wells when not pumping stands at from 2 feet

to 8 feet below the surface, varying at different seasons.

Heretofore the pumping has been done by means of two Pulsometer pumps, Well No. 1 being connected to a No. 3 Nye Pulsometer having a 3-inch discharge to the tanks; Well No. 2 with a Korting Patent Pulsometer No. 0.45. At a test made by the superintendent prior to installing the air lift, the two Pulsometers raised in two hours 44,507 litres, equal to 5,887 gallons in one hour, or 98 gallons per minute. This test was made when all the machinery was shut down, hence the supply of steam to the Pulsometers was larger and more regular than when the machinery is going. The superintendent estimates that if the test had been made when all the machinery was running, the quantity of water raised would have been one-fourth less. He calculates the amount of steam used by both Pulsometers at about 15 horse-power, and the supply of water was always more or less irregular owing to excessive condensation in the steam pipes, the Pulsometer at Well No. 1 being about 200 feet away from boiler room.

The air lift plant was a complete success from the moment air was turned on. So far only Well No. 1 has been connected, the central air pipe system being used. Photograph No. 1 shows the method of connecting; the smaller pipe (painted white) is the 2-inch air supply, the large vertical pipe is the 5-inch discharge pipe which is carried directly up to the roof and then along the floor of the roof, a distance of about 165 feet, to the tanks, where it again assumes a vertical direction to the top of the tank, where both water and air are discharged, making a lift of 28 feet from the mouth of the well, besides the horizontal "push" of 165 feet. It is intended later on to discharge the water into a small tank

FIG. 1—SHOWING PIPING AT WELL NO. 1, THE MACHINE TO THE RIGHT BEING THE DISCARDED PULSOMETER.

placed nearly over the well and high enough to let the water flow by gravity and syphon into the large tanks 150 feet away. This will obviate the friction and back pressure of the long horizontal pipe and of so many elbows. To the right of the well in illustration No. 1 may be seen the now discarded Pulsometer pump. The first test with the air lift in this well was made in June. Following is an abstract of the result as taken down by the superintendent of the mill:

Total length of 5-inch discharge pipe from well to tank, 192 feet, with 5 elbows.
Central air pipe in well, 1½ inches diameter, lowered to 30 meters = 98 feet below the surface.
Length of 2-inch air pipe from receiver to well, about 200 feet.
Speed of compressor, 142 revolutions = 98 cubic feet free air per minute, developing 10 H. P.
Starting pressure at receiver, 47½ lbs.

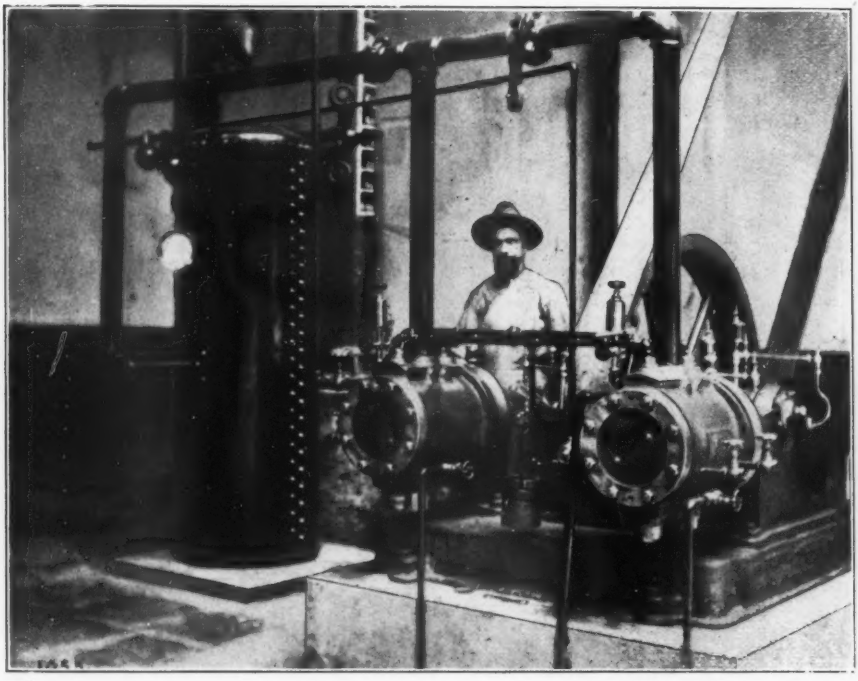


FIG. 2—COMPRESSOR PLANT AND FLOATING INDICATOR AND REGULATOR.

Total depth of Well No. 1, 180 meters = 590 feet.
Cased to the bottom with 5-inch inside diameter pipe.
Depth of water level from surface, when not pumping, 2 meters = 6 feet 6 inches.
Vertical height of discharge pipe above well, 8.5 meters = 28 feet.
Horizontal distance from well to tank, 50 meters = 164 feet.
Working pressure at receiver, 43 lbs.
Quantity of water raised per minute, 725 litres = 192 gallons.
Cubic feet free air per gallon, 0.51.
Horse-power per gallon, 0.0521.

The air compressor used (Fig. 2) is an Ingersoll-Sergeant duplex belt driven class "J," the two cylinders being 8-inch diameter by 6-inch stroke. The free air capacity of the compressor at its present working speed of 142 revolutions

is 98 cubic feet per minute. Making due allowance for the lower density of the atmosphere at this altitude (7,350 feet), this is equal to 78 cubic feet at sea level. The compressor, which is located in the main engine-room, delivers its air to a vertical steel air receiver 24 inches diameter by 6 feet high, set close by it (photo. No. 2), from whence it is conducted through 2-inch pipe a distance of about 200 feet to Well No. 1. This air pipe enters the 5-inch discharge pipe

One of the interesting features of this plant is the novel method adopted by Mr. Goyarzù, the superintendent, for keeping the depth of water in the tanks on the roof under perfect control automatically (see Fig. 3). A heavy wooden float is suspended on the water by means of a light wire, which passes over small pulleys along the roof and then down into the engine-room alongside of one of the iron columns that support the roof; this end of the wire carries a pointer attached to a counter

FIG. 3—SHOWING 5-INCH DISCHARGE OF WATER INTO THE TANKS ON THE ROOF.

through one of the horizontal openings of a 5-inch cross, placed just above the mouth of the well, where the air pipe, being reduced to 1½ inches, descends for 30 meters inside of the 5-inch pipe. On the opposite opening of the 5-inch cross is inserted a short length of 2-inch pipe with a globe valve, elbow and nipple, so that water may be drawn from this point whenever desired by means of rubber hose or for filling buckets, etc.

weight. As the float moves up or down the pointer is carried with it and indicates the depth of water in the tanks on a scale prominently painted around the column so that the engineer can see at a glance from any part of the room just how much water there is in the tanks. The same wire is extended and passing over another pulley which is suspended above the air cylinders; it is then attached to the weighted lever of the un-

loading device. When the float in the tanks has reached the desired height, say 80 centimeters, the wire pulls up the regulator lever and the compressor is unloaded, *i. e.*, continues running, but ceases to compress air until the lowering of the float in the tank releases the regulator lever and the machine starts compressing air again. By means of this "floating regulator" the wasting of water, which would otherwise go through the overflow pipe, is avoided and only the necessary amount of work is done by the compressor to keep the water tanks filled to the required level. This arrangement can be readily seen in the photo. No. 2. JUAN CUYAS.

The Use of Pneumatic Tools in the Preparation of Fossils.*

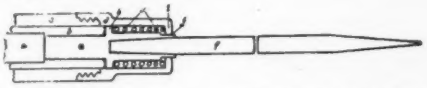
The tedious work of removing fossils from their matrix by means of the hammer, chisel and awl has led to various experimentation with machine tools in the hope of devising some more rapid method. The dental engine and the electric mallet have been in use in some laboratories for a number of years, and have proved very efficient in such work as the removal of hard matrix from small skulls. However, their efficiency has so far been limited to light work. This is probably due in a large part to the fact that the tools used are those constructed for the lighter work of dentistry. It is also generally conceded that electric appliances have not proved a success in percussion tools.

Pneumatic tools were introduced into the paleontological laboratory at the Field Columbian Museum by the writer some four months ago, and may now be said to have passed through the experimental stage. The application of these tools to fossil-cleaning has proved so successful that it has seemed worth while to call attention to their use in this work.

The pneumatic hammer as used in chipping and riveting metals and in stone-cutting is too well known to require description here. However, only the lightest hammers used in stone-cutting come within range of our present consideration. These are manufactured by a number of firms in the United States and are of two types, the pistol-grip and the straight cylinder. The latter type has been adopted by the writer on account of greater convenience in bringing the tool into use in work in all positions. Experimentation has shown that the smallest hammers on the market as stone-working tools are heavy enough for any work on fossils. A still smaller size would often be convenient.

The hammer in use consists of a cylindrical chamber in which a five-eighth-inch steel plunger having a five-eighth-inch stroke is caused to play upon the head of the chisel at the rate of 3,000 to 3,500 strokes per minute. This rapid succession of light blows sets up a vibration in the chisel which, with even a slight pressure against the work, gives it a remarkable cutting capacity. In fact a chisel so driven will cut an indurated clay as rapidly as an ordinary hand tool will cut chalk.

The chisels commonly used in stone-cutting are made uniformly of one-half-inch square or octagon steel about nine inches in length. Of these one and one-half inches of the head end is turned down to three-eighth-inch diameter, so as to fit into the chamber of the tool and provide the shoulder necessary to hold the chisel at the precise point which will render the stroke of the hammer most effectual. These chisels are used indiscriminately in all sizes of stone hammers and are ill adapted for the preparation of fossils. The requisite for such delicate work is a keen stroke under complete control. This has been in a measure attained by fitting an attachment to the stone-cutting hammer.



CROSS-SECTION OF PNEUMATIC HAMMER, WITH TOOL-HOLDING ATTACHMENT.

In the accompanying figure *a* represents the plunger, *b* the hard steel barrel and *c* the softer outer jacket of the hammer. A tempered steel cylinder *d* is attached to *c* by a heavy thread; this holds in position a separate tool head *e*, which receives the blow of the hammer and bears the chisel *f* in a taper socket. A coil spring *g* acting against the shoulders *h* and *i* in turn receives the blow of the hammer or any part of it not utilized in work at the point of the chisel. The tool head *e* is fitted to a square opening in *d* at *j* which pre-

* By E. S. Riggs, of Field Columbian Museum, for "Science."

vents rotation. The taper-socket holds the chisel in place so that it may be guided by the hammer; when desired the chisel may be readily released by placing in a vise and tapping the tool head lightly. One escape-vent is directed forward so as to blow away dust and small chips from the work. For chisels, one-fourth-inch round steel cut in six-inch lengths and drawn to a point of one-eighth or three-sixteenth inch in breadth is most efficient. For finishing a broader bladed chisel may be used to advantage.

This appliance makes it possible to dispense with the unnecessary weight of metal in the chisel so that a keener stroke and a greater cutting capacity result. At the same time the manipulator is relieved of the necessity of holding the chisel in place with the left hand and so avoids the benumbing jar caused by the vibration.

The advantages of this hammer over the old-fashioned hammer and chisel are its much greater cutting capacity and its freedom from the jar which causes so much breakage in specimens encased in hard matrix. The relative cutting capacity depends upon the nature of the material to be removed. If it be sandstone, by which tools are rapidly dulled, blocking off in large pieces by means of hammer and chisel will be found more expedient. Or if it be a very hard substance, such as quartz or chalcedony infiltrations, a method of spalling by means of a square-poled hammer may prove more efficient than either. But in limestone or any of the indurated clays the superiority of the pneumatic hammer is at once evident. This is especially true in the case of complicated specimens where there are deep cavities or foramina to be developed. In such work the pneumatic chisel can be used wherever its point can be introduced, while with the old-fashioned hammer and chisel one is often at a loss for room to hold and strike. The cutting capacity of a chisel is much greater also when used with the pneumatic hammer, as the point can be made much harder without danger of breaking. Chisels made from a high-grade English steel of 1.4 per cent. carbon chilled to a file-like hardness may be used four or five hours in concretionary clays without need of grinding.

The advantage of relieving the specimen from the jar of the hand-hammer can scarcely be overestimated. In working out dinosaur vertebræ from a concretionary matrix by means of hand tools we have often found it necessary to break the specimen to pieces with a hammer in order to remove the chalcedony-filled masses of concretion from the cavities. The use of the pneumatic chisel has made it possible to remove the matrix from such cavities, with but little injury to the specimen. The tendency to chip off thin edges with flakes of the matrix is also avoided.

Skill in the use of these tools is readily acquired. By adapting the size of the chisel to the work in hand and gauging the amount of air admitted to the tool by means of a push-button throttle valve, the stroke can be reduced so that a scale may be removed from the most delicate surface.

Efficiency Test of the Air Lift.

Notice has already been given in COMPRESSED AIR of the new form of air lift, designed and patented by Mr. Jos. Price, an English engineer. This possesses a new rising main which, unlike the old ones, increases in diameter as it nears the top. It is claimed by the inventor that if permitted to do so the compressed air will slowly expand while rising, as the pressure of the water above is lightened. To admit of this expansion the water above the air must of necessity be moved at an increased speed. The claim is that a large portion of the energy stored in compressed air has heretofore been uselessly consumed in imparting this additional rapidity of motion to the water.

The *Refrigerating Engineer*, an English publication, tells of an efficiency test recently made of an air lift of this type at the electric supply station of the Central London Railway at Leeds Road, Ilford, London. The report of the test is as follows:

"The well is bored 10-inch diameter to 400 feet deep, the rest of the water level being at 44 feet before pumping. The plant was arranged as for raising a supply of 10,000 gallons from 130 feet below to 20 feet above surface, and (excepting as regards the tubes) on lines dictated by the best American and German practice for parallel rising mains, which require 144

cubic feet of air to be compressed for the above duty, equalling a ratio of at least 5½ vols. of air to 1 of water, and a ratio of submergence to lift of 3 to 2.

"The rising main is of tubes increasing in area as the air expands in rising, thus maintaining a minimum of friction throughout, and has an internal air tube with adjustable annular ejector for economizing the air used and utilizing its velocity of discharge, which is at 336 feet below the surface, the water being delivered for testing purposes at 5 feet above surface over a weir fitted with a gauge for measuring the depth of flow.

"The air compressor, some 50 feet from the well, is of the two-stage type, with intercooler, proved to compress 144·2 feet of free air to 100 lbs. pressure of 115 strokes a minute, indicating 22 horse-power in the compressor, and is driven directly, through gearing, by an electric motor combined on the same bed plate and arranged to run the compressor at the above speed, viz., 115 strokes a minute.

"The plant was run continuously for 14 days and nights, lowering the water to an average level of 127·0 feet from the surface, or a total lift of 132 feet, the average flow over the weir, gauged every hour, being 3·31 inches, or 11,660 gallons per hour, say 195 per minute.

"During this run it was found that the air compressed (144 cubic feet) was much in excess of that required, and that a quantity could be leaked away without affecting the flow. This quantity was gauged by a hole through a thin plate as about 44 feet, thus reducing the volume actually used to 100 feet per minute, or a ratio of 3·2 volumes of air per volume of water, with lift 132 feet.

"On the completion of the above test, arrangements were made for slowing the motor, ultimately to 83 revolutions of the compressor, or as 115, 83, 144, 104 cubic feet, at which speed the flow was 3·80 inches, or 200 gallons per minute, the total lift being $119 \times 5 = 124$ feet, the water having risen in the well during the stoppage. This works out as 3·25 volumes of air per volume of water, thus verifying the estimate made previously by leakage measurement.

"Lifting 200 gallons per minute through 124 feet equals 248,000 foot pounds, and the power is as 144·2, 104, **22, 15·88 horse-power or 524,000 feet** pounds, so, dividing the former by the latter gives about 47·3 per cent. efficiency.

"For fair comparison with precedent practice it is necessary to correct:—1st, for excess of the submergence over the standard 3 to 2, in this case, 31 feet; 2d, for the temperature which at time of observation was about 80 degs., or 25 degs. above the normal temperature. With these corrections the volume ratio of air to water becomes 2·7 to 1, and the efficiency 5·55 per cent."

Pneumatic Tube Service.*

The mythology of the ancient Greeks and Romans represents the messenger of the gods as a young fellow whose heels are shod with wings through which the air became the medium of his flight in conveying the messages and commands of his imperial masters. In the sacred poetry of the ancient Hebrews the "wings of the wind" constituted the chariot of omnipotence in the swift execution of sovereign purpose and command. The ancient literature of numerous other early civilizations is replete with the same figure.

In our day the "wings of the wind" as messengers have passed from symbol to fact—from mythology and poetic fancy to practical reality. The lithe, athletic Mercury, winging his swift course on the breast of a favoring wind with messages from imperial Jove to the lesser deities has become a little cylindrical "carrier," darting away with the rapidity of a bird on the wing under the impulse of a confined and directed air current, carrying its message safely locked within against harm or loss, and, after a brief period of swift flight, delivering its charge at its appointed destination.

The art of pneumatic dispatch tubes for the conveyance of messages, parcels, freight matter and even passengers in its theoretical aspect is over two centuries old. It is not the purpose here to treat of its early history and experimental development. It may, however, be noted that the art had its earliest development in Great Britain in the first half of the last century, and the records of the British Patent Office for the twenty years between 1835 and 1855 show astonishing activity and interest among

* By Edmond A. Fordyce, for *Cassier's Magazine.*

inventors in the art of pneumatic transmission of express and mail matter through closed conduits and tubes. The streets of London, Paris and other cities of Continental Europe were the scenes of numerous early experimental pneumatic tube plants, most of which, though successful mechanically, failed because of financial difficulties.

One of the oldest of the United States patents relating to the art was granted more than thirty years ago to Mr. Alfred Beach, of New York. It provided for a tube system which contemplated the carrying of passengers in cylindrical carriages traveling in a 10-foot tube or conduit and designed to be driven by an air current at a speed largely in excess of modern express railway speed. The drawing of this old patent shows the car at a station, with doors in the walls of the tube and car thrown back and passengers leaving and entering the car. But the scheme did not go beyond the experimental stage, though it is but fair to say that the causes that proved fatal to its practical development did not so much reside in mechanical impossibilities as in the enormous expense and outlay of capital which the construction, operation and maintenance of such a plant would have involved. But in our day of gigantic engineering and financial operations initial expense constitutes no serious obstacle to an enterprise which can be subsequently made to pay fair profits on the capital invested; and if on its mechanical side the fuel energy required for the transmission of a given weight of matter a given distance by pneumatic tubes can be reduced below the amount used to accomplish the same by the steam locomotive or electric motor, we may yet see pneumatic transmission applied to the direct propulsion of vehicles for passenger service, as well as for mail and express service.

Undoubtedly the most extensive, and thus far the principal, service which the pneumatic tube art has rendered has been in transmitting money and memoranda of sales between the sales counters and the cashier's office in dry goods and other shops—a mechanical convenience with which the public has grown so familiar that it is now regarded as an indispensable part of the equipment of every first-class retail establishment. And along with the development of the pneumatic store-service system has come the more tardy application of the same principle to the distribution of mail and express matter in large cities. Several of these have for a number of years enjoyed the benefits of rapid collection and distribution of mail matter through underground pneumatic tubes.

The earliest practical application of pneumatic transmission outside of shop and mail service was in the distribution of telegrams and telegraphic news matter. Prior to 1887 the Western Union Telegraph Company, in the United States, had established in New York a pneumatic service of its own for sending messages singly or in bundles between the branch stations and the main office, and for supplying the daily newspapers of the city with their associated press telegrams and special dispatches, these being sent in carriers through 1½-inch individual pipes leading to each point of collection and delivery.

In 1893 the City Press Association, of Chicago, out of patience with the slow and unsatisfactory delivery of telegraphic news dispatches by messenger boys, contracted for and installed beneath the streets of Chicago fifteen miles of the most costly and elaborately constructed pneumatic tubes ever put into service. These tubes connected the main office of the Western Union Telegraph Company with the offices of the association, the various newspaper offices, the City Hall, the Central Police Station and several other points, and since that time messages that, in the hands of some dilatory messenger boy, used to keep the newspaper presses waiting for half an hour, are now shot to their destination in but a fraction of a minute. This system, which was designed only after a thorough inspection of all the leading systems of Europe, is perhaps the most satisfactory of its kind ever installed, no expense having been spared to make it perfect in every detail.

Pneumatic tubes are coming to be regarded as an indispensable part of the mechanical equipment of large public libraries. In one of the earliest pneumatic transmissions of this kind the slips calling for the book, or books, desired were shot from the central distributing desk through pneumatic tubes to attendants at the stacks, the books themselves being sent to and from the delivery room by basket conveyors. Similar systems have since been installed in a number of large libraries, and constitute probably the most important and effective part of the time and labor saving equipment of such institutions. As messengers, they do their work with all

the celerity of the telephone—and do it withal in perfect harmony with the spirit of silence that pervades the atmosphere of a library, which the telephone could not do.

The success of large-tube systems for the transmission of mail matter has led to an extension of such systems in express service for the delivery of parcels and packages from the retail shopping districts of large cities to the outlying residence districts. Through such large tubes merchandise and express matter may be sent, with but a few seconds or minutes at the most consumed in the actual transit between the distributing and receiving stations. The immense convenience of such a speedy system of parcel delivery may be appreciated from the fact that purchasers in shops frequently find that their purchases have been delivered and are awaiting them long before their return home.

Of late years pneumatic tubes have come to be extensively adopted also in warehouses, packing-houses, railway freight depots and other similar places. In the case of warehouses and supply houses of all sorts, the tubes are laid between the various buildings, and serve to connect the main office with the different shipping and receiving points of the establishment. Orders, requisitions, receipts and all kinds of mail matter are sent through these tubes, dispensing with the services of messenger boys heretofore employed; and, what is more important, eliminating almost entirely the time element—almost to the same extent, in fact, as the telephone and telegraph have eliminated it.

Three of the largest American railway systems recently installed in connection with their freight depots systems of pneumatic tubes by which all freight receipts, way bills, checks, etc., received at the different doors are dispatched to a central office, signed and returned to the door of the warehouse from which they were received, thus permitting the teamster to get the goods without the necessity of going to the main office, waiting in line and then returning to his wagon. It is, perhaps, impossible to estimate the time that is thus saved; but it would be no exaggeration to say that where business is heavy this pneumatic system saves from a quarter to a half hour of an employe's time in connection with each delivery.

One large manufacturing company uses the system for connecting different buildings of its plant, and sends blue prints, small tools, samples of material, etc., through the tubes from different departments, all connecting with a central office, something like a telephone exchange, where the goods are re-sent, if necessary, to other buildings or departments.

One large electric supply company recently installed a pneumatic tube line over half a mile in length, through which orders received at the main office are sent to the railway warehouse and are filled and shipped from there. Previous to the adoption of the pneumatic tubes these orders were sent by messenger boys, a method which involved a considerable loss of time, and frequently a mistake or loss in the delivery of the order itself. In another large pneumatic messenger installation the system has dispensed with the services of fifteen messenger boys; and in filling orders for railway delivery from twenty to thirty minutes are saved on each order, which means that an order received twenty or thirty minutes later than formerly is now filled and gotten off on the same day the order is received, while before the adoption of the tube system these orders would frequently have to go over until the next day. Many large factories have put in pneumatic tubes between their main offices and their various departments for the quick transmission of orders, blue prints and paper memoranda, which have hitherto required the services of one or more messenger boys. In still other departments of the business and manufacturing world too numerous for specific mention air currents as messengers to replace the tardy, tired and sometimes lazy feet of messenger boys and men are gradually coming into use. The old adage that "Time is money" was never truer than in the present day; and a system of messenger and express service that practically converts time into money, besides contributing an increased element of safety, is bound to meet with public favor and acceptance to an ever-increasing extent.

Compressed Air Running Steam Engines.

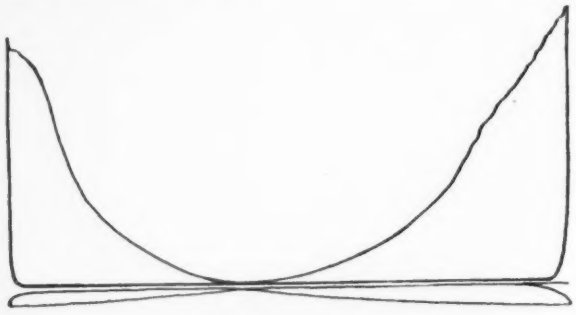
Some 50 engines are running in Norwich, Conn., by compressed air generated at the power station of the Continental Compressed Air Company at Taftville, on the Quinebaug river, and results

so far show that the power is entirely satisfactory if the cost does not prove to be too great. These engines vary from 2 to 250 horse-power. The plant is located three miles from the furthest point of distribution, and compressed air is carried in pipes this distance with immaterial loss of pressure. The 90 pounds pressure at the compressor is reduced to 88 pounds at the furthest point of consumption, and the average loss of pressure in transmission is only about one pound. Fifteen hundred horse-power is thus distributed in the city of Norwich.

The Taylor system of hydraulic compression is used, the plan being similar to those at Magog, in Quebec, and at Ainsworth, in British Columbia. A dam gives a fall of 18 feet and at the foot of the fall is the compressor. The shaft is 208 feet deep and 24 feet in diameter, opening toward the bottom into a bell-shaped chamber with a maximum diameter of 52 feet. The downflow pipe in the centre is 14 feet in diameter. Generally speaking, the downflowing water receives large quantities of air in the form of bubbles, a tendency to a vacuum caused by the rapid flow compelling this influx of air. The bubbles are compressed in the long fall, and the air is separated from the water by means of a separator at the base of the shaft. The air is dry, no trouble resulting from the presence of moisture not even so much as in air compressed in the ordinary mechanical compressor.

The Continental Company is not yet ready to announce the price of its power. The initial price, to prevail until arrangements are made for metering, is $50 a year per horse-power. Some anxiety is expressed as to what the future price will be. The customers realize that the plant cost a good deal of money because of accidents during freshets, several times the machinery being washed away by the Quinebaug, which, though like a mild trout stream at ordinary seasons, in time of freshet is a roaring torrent. It is said that it cost nearly $750,000 to build the plant complete.

But while the cost of the power may be more than is required to run a steam engine by steam generated on the premises, yet the compressed air is cheaper than electricity distributed from stations in the vicinity of Norwich, it is claimed, and the advantages over steam are material, especially in the ability of an engine to stand up to its work when a great additional load is suddenly put upon it, as in such a plant as that of the Rogers branch of the American Wood Working Machinery Company, at Norwich, where heavy wood working machines are tested. A test of the engine under compressed air was made, every machine in the shops being started up, throwing three times the average load upon the engine. The only change noted was that the revolutions went down from 124 to 118, where under steam the fall would be from 124 to 90 revolutions with only twice the average load.



CARD FROM AIR OPERATING ENGINE.

Compressed air is admitted to the cylinder of an engine just as steam had been admitted. No change was made in the engine. The compressed air is passed through a heater before going to the

cylinders, the heating process adding greatly to the efficiency, so that heating the air to 324 degrees F. gives an additional horse-power at the rate of about $8 a year. The advantage over steam is that no matter what load is put on the engine the gauge pressure remains unchanged, instead of having the steam pulled down, as must happen with the ordinary engine and boiler if heavy machinery, such as wood planers and molding machines, are set going on top of the usual shop load.

Some idea of the workings of compressed air as a substitute for steam in a steam engine may be obtained from the accompanying card reading of a Corliss engine: Boiler pressure, 88 pounds; revolutions per minute, 55.5; scale, 40; piston diameter, 26 inches; stroke, 48 inches; piston rod, 3 13-16 inches; exhaust pressure, 3 pounds; developing 80 horse-power.—*Iron Age.*

Lifting Water by Compressed Air.*

At the last meeting of the society, held in Warren, I had the pleasure of listening to a paper entitled, Air-Lift Versus Deepwell Pump, by Brother McConnoughy. The interest taken in that paper, together with numerous requests, including one from our president, for a paper on this subject, has led me to present some of my observations on the operation of the air-lift pump. I will confine the first paper to the air-lift itself and the well, and will give the principal proportions of the apparatus as it is generally used, viz., in what appears to be the more practical and economical form. I shall mention very briefly the apparatus for producing the compressed air required, because information of that kind can be obtained of almost any manufacturer of air compressors, as well as from works on compressed air. The history of the air-lift pump I shall omit altogether, as it would add but little information of a practical nature. I might state at the outstart that I have failed to find in printed form information on this subject which would seem to be of any practical use to engineers who may be called upon to construct or to superintend the sinking and fitting up of a well for an air-lift. The information at hand at the present time seems to be very scarce, indeed, and this is especially true in view of the large numbers of air-lifts in successful operation and the high economy obtainable in this type of pumping apparatus.

The complete apparatus necessary for the successful raising of water by the air-lift system consists of an air compressor and the necessary air regulators; an air-tank or receiver large enough to furnish a steady flow of air to the well, and to break up the pulsations of the compressor; a pressure gauge and valves suitable for regulating the pressure and flow of air, and the necessary length of pipe of the proper sizes. In order to enable the well to work successfully and economically the pipe should be properly proportioned. When the pipe is too large the water is apt to blow out in a spray and with great force, which is obviously very wasteful both of air and water. When the pipe is too small the air is apt to rise to the surface of the water in small bubbles, and without producing the desired results. When the air-pipe is outside of the water-pipe, I have found the proper relation between the diameters of the air and water-pipes to be as 1½ to 4, which gives a ratio of actual cross-sectional area of 6.24. When the air-pipe is situated inside the water-pipe the same ratio of actual cross-sectional areas should obtain, and in this case the diameter of the water-pipe is

$$D = \sqrt{\frac{a \times 6.24 + A}{.7854}},$$ in which a and A represent the actual internal and external areas of the air-pipe. The proper areas of the air and water-pipes, together with the required depth of submersion and the introduction of the air into the water-pipe at the proper point, are the principal factors which determine the success of the air-lift.

The water-pipe should be submerged to a depth of 18 inches for each foot lift above the lowest water level in the well; in other words, the best results are obtained when submersion = .5, the lift being measured from the lowest or the working water level, as it is called. It will be seen that the depth of submersion for the best results should not be less

* A paper read by Gustav C. H. Freidrich before the Ohio Society of Mechanical, Electrical and Steam Engineers.

than 1½ times the total lift measured from the working water level.

When the well is being worked, the water level falls below the level reached before water is pumped out. To illustrate the foregoing rule, suppose we wish to elevate water 25 feet above the surface of the ground, and that when drilling the well, water is obtained at a depth of 40 feet below the surface. The lift is now 40 + 25 = 65 feet. Applying the foregoing rule for depth of submersion we have 65 × 1.5 = 97.5 feet, or practically 100 feet, thus giving a total height of 165 feet from the point where the air enters the water-pipe to the point of discharge. After drilling to a depth of 165 — 25 = 140 feet, we are ready to find the working water level in the well. First put the water and air-pipes into the well; then drop a float attached to a string into the well. Pass the string over a pulley and attach a weight to the free end. The weight should be just heavy enough to take up the slack in the string and at the same time allow the float to descend with the water level as the latter is lowered by pumping. The distance the weight rises will indicate the depth of the working level below the level first obtained in the well, and the latter level should be employed when making calculations involving lift and depth of submersion.

A very simple as well as convenient arrangement for measuring the fall of the water level in the well can be made as follows: Take a pulley whose circumference is 12 times the circumference of the shaft upon which the pulley is mounted; then wind the float string around the pulley and fasten another string to the shaft, so that it will be wound on the shaft as the float string unwinds from the pulley It will be seen that this arrangement reduces the travel of the string on the shaft to a convenient distance and one that can easily be measured. Suppose the water level in the well falls 10 feet. The corresponding additional depth of submersion will be 10 × 1.5 = 15 feet, and if the well is not deep enough it should be drilled to a sufficient depth to permit the increased depth of submersion to be obtained, and this is done in order to make the total depth of submersion equal to 1½ times the lift, which proportion, as has been pointed out, is necessary for the best results. If it is not practicable to increase the depth of submersion after finding the working level, the height of the lift may be decreased a corresponding amount; otherwise the efficiency of the lift will be to some extent affected. If the well had been drilled deeper than necessary at the outstart, the increased depth of submersion could readily be obtained by simply lowering the pipes to the required depth. It will be seen that the lower water level in the well also determines the necessary change in the point at which the air should enter the water-pipe. With a fall of 10 feet when pumping, the air should enter the water-pipe at from 38 to 40 inches from the lower end of the pipe; with a fall of 5 feet the air should enter at from 24 to 26 inches from the lower end of the water-pipe, and with a fall of from 1 to 3 feet it should enter at a point 18 to 20 inches from the lower end of the pipe. For other distances the same ratio may be used. A well put down to the depth previously determined and fitted with pipes of the sizes indicated by the rule can be cemented over and buildings erected over it without fear of trouble, because the well will need no further attention, and all that is required is simply to supply it with air as long as the pipes last. A number of wells can, of course, be operated from the same compressor. The necessary machinery can be located in the engine-room or in any convenient place, and the air-pipes run to the different points of distribution.

Coming now to the question of air required for raising water, it is estimated that 1 cubic foot of air will raise 1 gallon of water, but in wells that are properly proportioned there will be a saving over the amount of from 40 to 47 per cent.; that is to say, the air used will be 60 per cent. of the above estimate as the maximum and 52 per cent. as the minimum. This serves to illustrate the fact that wells vary, as, for instance, along rivers, where the water rises and falls, causing the water level in the well to fluctuate. To illustrate the application of the rule for volume of air required, if we wish to raise 100 gallons of water we shall need 60 cubic feet of air as the maximum and 52 cubic feet of air as the minimum, the required volume carrying from the maximum to the minimum according to the conditions in each individual case. The average air pressure is 60 pounds per square inch. When starting to raise

water it requires a somewhat higher pressure because there is a solid body of water from the surface in the well to the point at which the air enters the water-pipe, and this column of water has to be moved by the first discharge of air. When the well has reached its normal working condition the water-pipe will contain a number of short columns of air and short columns of water. These short columns of air and water are discharged alternately, and in the pipe they form a continuous chain, the intermittent discharge continuing as long as the proper amount of air is supplied and as long as there remains water to be pumped.

The principle upon which the operation of the air-lift depends may be explained as follows: The pressure of the atmosphere being 14 7-10 pounds, in a perfect vacuum water can be lifted to a height of 34 feet. We know that as the water piston is drawn forward in the cylinder a partial vacuum is created behind it and the pressure of the atmosphere on the outside of the suction pipe causes the water to rush into the latter. The suction valve then closes and on the return stroke the discharge valve opens the piston, forcing the water to a higher level.

In the air-lift pump the pressure of the atmosphere is not removed from the surface of the water in the pipe, as it is in the suction pipe of an ordinary pump. We have the atmospheric pressure on the surface of the water outside of the well and also in the pipe. The short columns of air previously mentioned act as pistons in the air-lift pump, the propelling force being that due to the difference in specific gravity between air and water. The specific gravity of a solid is the difference between its weight and the weight of a like volume of distilled water at 39.2 degrees F., the weight of the water generally being represented by unity, or 1. Taking the weight of water as 1, the specific gravity of air is .0012. Air being elastic and compressed to 3, 4, or 5 atmospheres, as the case may be, when liberated under the water is found to be very buoyant, and, as expansion is confined to the limits of the pipe, it forms a large bubble and carries the water above it to the surface, the air column becoming longer as it ascends on account of the removal of the weight of water above it, thus allowing the air to continue to expand, until finally it flows from the pipe a little above atmospheric pressure. It will be seen that the water which is removed by the air lessens the weight of water in the pipe, or, in other words, the weight of the column in the pipe is less than that of a similar column outside of it. This in turn causes the water to rush in at the bottom, because of the greater weight of the column on the outside. Other bubbles are formed, thus causing a continuous chain of short columns of air and water as long as air is supplied. One important advantage to be derived from the use of the air-lift pump where water is to be used for condensing purposes or domestic use is that the air during expansion absorbs heat, and this tends to lower the temperature from 2 to 4 degrees F.; that is, water having a normal temperature of 50 degrees in the well will have a temperature of from 48 to 46 degrees when discharged.

There is no particular advantage to be gained by employing special arrangements for introducing the air into the water-pipe. The air may enter from the side or at the centre with equally good results. The economy of this system can be figured out by any engineer without much trouble, because about all that is necessary is to find out how much steam will be required to compress 1 cubic foot of air to the required pressure, which may be taken at 60 pounds when making calculations.

The cost of compressing air offers good material for a subsequent paper on the air-lift pump.

The "Liernur" Pneumatic Sewerage System at Stansted.

Considerable interest has been taken by municipal engineers in the first British installation of Liernur's pneumatic sewerage system at Stansted, in Essex, which has now been in operation for about a year. Stansted is a large village with a population of about 2,000; its higher portion already possessed a system of sewerage by water carriage, but for some years past the lower portion had given the district and parish councils much anxiety as to its efficient drainage, owing to the physical difficulties presented. The basin-like formation of the country rendered the adoption of

a system of sewerage by gravitation almost impossible, owing to the large expenditure of water which would have been necessary for adequate flushing.

The engineers of the " Liernur " system availed themselves of every possible fall for the conveyance of the sewage, a great part of the liquids reaching the storage tank by gravitation. For the carriage of the sewage remaining in the syphon boxes and sewers the vacuum suction is utilized, as frequently as experience dictates. Consequently, by this system of conveyance it is possible to guarantee that the whole network of sewers is thoroughly cleansed and filled with pure air every day, or as often as desirable. From the starting of the gas engine, the complete service of the " Liernur " system over the whole network of street sewers and house connections, in all about two miles, takes only fifteen minutes.

The area served by the " Liernur " system is of a varied description so far as levels are concerned; with one exception the branch sewers are laid at an average depth of 2 to 3 feet. The one exception is the extremity of the pipe line crossing the railway, and this has been laid at a lower depth (9 feet), in order to allow of the connection of the sewers of a large building estate now being developed. No provision was necessary for storm water drainage, the village possessing a system of surface water sewers. A 4-inch rising main is carried from the pumping station to the high level existing sewer, from whence the sewage is conveyed by gravitation to the irrigation farm. The complete system is of cast-iron pipes, fittings, etc., throughout, and as each pipe was laid, the joints were tested by water pressure.

The pumping station is small. The machinery consists of the following: A boiler plate vacuum reservoir (with a capacity of about 2,800 gallons), provided with gauge glass and safety valve; a gas engine, 8 h.-p.; a vacuum pump of ¾ h.-p.; a lifting pump, for pumping the sewage to the high level sewer; and pulleys, cocks and other small fittings. Adjoining the pumping station is the storage tank, with a capacity of 30,000 gallons, which represents the quantity of sewage estimated to be delivered in three days. The lifting pumps and storage tank could be dispensed with and a lower power gas engine used in most cases and where the pumping station is situated immediately at the outfall works.

We understand that the capital cost at Stansted was under £2 per head; the working expenses come to 10d. per head per annum (including lifting the whole sewage 40 feet). The system has now been working at Stansted satisfactorily for the last ten months, during which period the population now connected has increased from 800 to 1,000, comprising all the lower district of Stansted.—*Engineering Times* (London).

Washing the Air.

In order to meet unusual conditions at its Pittsburg station, the Pittsburg and Lake Erie R. R. has adopted a system of washing air used for heating and ventilating the building, which is now being operated with success under the direction of J. N. Campbell, electrical engineer of that company. Owing to its original features it has excited considerable interest and comment.

SPRAYS AND BAFFLE PLATES IN AIR WASHER.

Leading down from the roof there are two large air ducts about 8 feet by 20 feet each, which extend to the basement directly to the washers. These air washers are rectangular iron boxes

PLAN OF DRYING PLATES

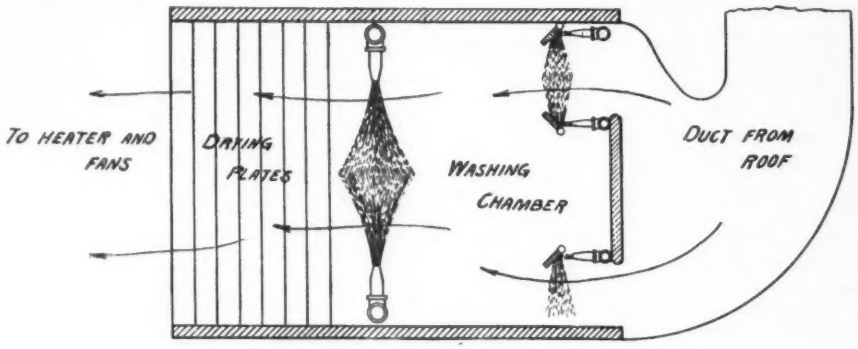
about 12 feet by 5 feet wide and 8 feet high, the air entering along the top and bottom of one of the sides. This air on entering passes three sets of water jets, the two top ones having 12 sprays each

and the bottom one 14 sprays. The air leaves this washer through the opposite side of the chamber, which is open, but in doing so passes through two more sets of the water jets, one of which sprays vertically downward from the top and the other one vertically from the bottom. Each of these sets also has 12 sprays. These sprays are about 11 inches apart on each pipe and are simply open nozzles about one-eighth of an inch in diameter, and the water is directed with a pressure of 15 to 20 pounds per square inch against a baffle plate which is adjustable, allowing the spray to be turned in any desired direction, as shown in the sketch.

The air from the washing chamber passes by a series of seven rows of plates against which it impinges and drops the water which is held in suspension. These plates are formed as is shown in the sketch on the opposite page.

From these drying plates the air passes through a heater having grates through which water is circulated at any temperature to give the air the desired temperature, and from this heater the air is drawn by a fan and discharged into the building. There are three of these fans and four suction fans drawing off the impure air and discharging it through ducts to the roof.

This system, it is said, cleans the air very thoroughly and provides the entire ventilation for the building, there being no windows in the building that can be opened, and a constant temperature of from 68 to 72 degrees is maintained during the entire year. The air seems to have very little moisture retained in it, and the pressure that is maintained through the building is about one-half an inch of water. The entire system was manufactured and installed by the Thomas & Smith Co., of Chicago.



PLAN OF AIR WASHERS.

Pneumatic Hammer for Railway Shops.

Finding the demand imperative for pneumatic tools in a railroad shop, R. M. Cole, foreman of the Union Pacific's shops, at Ellis, Kansas, designed one himself which has since been used there with considerable success. He has constructed a 58-pound pneumatic hammer which is used for breaking out staybolts and shearing crownbar bolts. It will shear, he reports, a 1-inch bolt at one or two blows, and can work at the rate of 50 or 60 blows per minute. He has also made a small one of 22 pounds for driving out flues. This one, it is said, will knock out a set of 200 flues in an hour and a half. Two men are required to operate either hammer.

Mr. Cole himself has described the operation of the pneumatic hammer as follows:

"The valve for the large hammer is of the piston variety; it has two rings on each head. The heads are 1⅜ inches diameter, ¾ inch thick and coupled on a ⅜-inch rod 4⅛ inches apart, back end of the stem being coupled to a lever. The bushing is 1⅜ inches on inside, 1⅝ inches on outside, and is 10½ inches long.

"The casing for the bushing is made

of three 1¼-inch gas-pipe Ts, with the thread drilled out to 1⅜ inches in diameter, and the centre bored out ⅛ inch large to allow the air to pass entirely around the bushing. They are held together with a collar on one end and a nut on the other end of the bushing. The bushing has twenty-six ¼-inch holes for each port; the holes are arranged in two rows running entirely around it, thirteen in each row. The ends of the T are faced off to insure an air-tight joint. The barrel of the hammer is common 5-inch pipe, with heads grooved for pipe to fit in, and held together with four ⅞-inch bolts. The barrel is 24 inches long, with ports so drilled as to allow pressure to escape and prevent a rebound. The hammer is made from an old crankpin turned to fit the pipe loosely, the pipe not being bored. The smaller hammer has only one row of holes at the end. It is about 7 inches long. Each hammer has a steel pin in the end to strike the bar, which is held by the gas-pipe. The small hammer uses 1-inch Ts bored in the same manner as the large one. Both hammers use the same bar, which must be a fair fit in the 1¼-inch pipe. The small hammer is very convenient where a heavy blow is wanted on a bar, and can be operated easily and quickly."

Pneumatic Tube Franchises.

Mayor Harrison's action in sending back to the Chicago City Council the pneumatic tube ordinance attracted considerable attention to the terms which the Chicago Postal Pneumatic Tube Company, the Chicago branch of the Pneumatic Service Company, made with that city. The ordinance has since been revised, passed by the Council in its new form and returned to Mayor Harrison for his approval. The revised ordinance now provides for 3 per cent. of the gross receipts to be paid to the city as compensation. In addition, a forfeit of $50,000 is required as a guarantee that eight miles of tube will be completed in one year. The city also gets from the company without charge a double line of conduits to carry fire-alarm and police telegraph wires from the downtown district to the stock yards. The company is also to dig the trenches, supply the conduits and turn them over to the city without cost. By the provisions of the ordinance the company is absolutely limited to the transmission of mail.

It is interesting to note that in Boston the parent company has a 99-year franchise with the privilege of carrying parcels as well as mail, and gives only 2½ per cent. compensation.

In St. Louis the only compensation is 5 per cent. after the first four years. In Philadelphia the company has a perpetual franchise for both mail and packages. There is no compensation at all on the mail contract, and 3 per cent. annually on the gross receipts of the package delivery.

The Shepard Pneumatic Motor Hoist.

Compressed air as a motive power for hoisting is now so widely used, and may so admirably fulfill the requirements, particularly for handling light and medium loads, that a review of some of the conditions of use which seem to contribute to its satisfactory and economical application, should be of interest.

The pneumatic motor hoist is of comparatively recent development, and is still in its formative state. It has reached no general form common to all makers, but is found in nearly as many separate and distinct designs as there are individual builders. Consideration of the subject will, therefore, be limited to the application of compressed air for hoisting, only in this type of hoist.

The small pneumatic motor is not of itself very efficient; the success which it will meet, therefore, in competition with other forms of motive power for hoisting, will depend largely upon its excellence in other respects, and also upon the efficiency of the hoisting gear to which it is attached. It was early recognized that the compactness, simplicity, lightness, and ease with which it could be installed, would give the pneumatic motor hoist a decided advantage over any other hoisting apparatus of its class, provided in other vital characteristics it could be made satisfactory. It is practically the only form of power hoist which can be suspended by a single hook and occupy a sufficiently small head room to permit its use in all places where the hand chain hoist was formerly employed.

One of the first problems met in designing the hoist was the selection of a suitable type of gearing, to reduce the speed of the motor and to intensify its power sufficiently to enable it to handle the maximum load. The choice of a type of gearing like the worm or differential

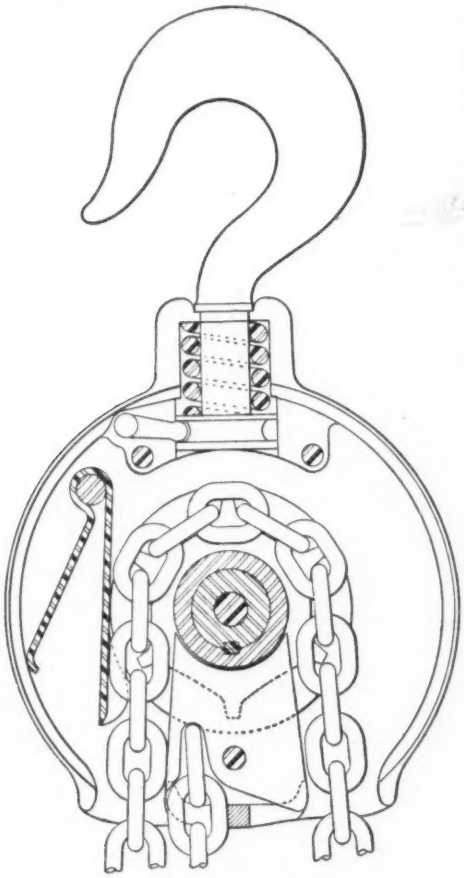


FIG. I.

would have eliminated all problems, such as sustaining the load and its smooth and safe descent. Unfortunately, however, any type of gearing which will retain the load without a brake, will be inefficient. Lowering a given load liberates exactly the same amount of power as was absorbed by it while being hoisted. The hoisting mechanism would reverse and permit the load to run down, unless the measure of its friction is equal to or in excess of the power stored in the object lifted. If the measure of its frictional loss equals or exceeds that of the useful work done, its efficiency will not exceed 50 per cent., and will probably be much less. The convertion of the motive power of the steam plant to actual hoisting, by whatever means, is accomplished only by several transformations. The careful engineer will, at least, look with regret upon a loss of so much as 50 or 60 per cent. in a single one of the transformations necessary. As a matter of fact an efficiency of 40 per cent. is all that may be reasonably looked for in the best worm or differential types of hoisting apparatus, and in any but the very best of its class it will be even less. If the hoisting mechanism is, however, made up of a train of spur gearing of efficient design, an entirely new set of conditions are introduced. When power is shut off from the motor, an instant application of a brake is necessary to retain the load, and this must be partially continued while the load is being lowered, or else the motor must be capable of absorbing nearly as much power when it is running backward as it gave out in the act of hoisting. In the latter case, complete release of the brake is practicable and preferable. The substitution of spur gearing offers a perfect solution of the problem so far as securing high efficiency is concerned. The loss of power with spur gearing need never exceed 25 per cent., and may be reduced to 20 per cent. or less; combined with a high speed pneumatic motor, it corrects the only remaining difficulty, that of sustaining the load safely, and controlling it during descent. Unlike the electric motor, the pneumatic motor is capable, not only of developing power, but in equal measure of absorbing power, it may, therefore, propel the gearing while hoisting the load, or restrain the gearing while lowering the load. Its ability to fulfill the latter function, and thus avoid the complicated apparatus which would otherwise become necessary, gives to it an advantage which far outweighs its small lack of efficiency. A high speed pneumatic motor was, therefore, chosen because of the ease and certainty with which the load could be sustained by a brake applied directly to the motor shaft; the high speed of the motor insures a high

ratio of gearing between the lifting sprocket or drum, and the motor; and insures the load being sustained even with a very light application of the brake, hence with a brake of moderate power, a large margin of safety is obtained. High speed in the motor, and consequently a high ratio between the motor and load hook for hoisting apparatus, affords relatively

and compression will increase until the load is arrested. In practice, two or three turns of the motor only will be necessary to bring the load to rest. Absolute safety is, therefore, offered against accident, even with the most careless operative. The throttle and brake operate in conjunction; the brake automatically grips the motor, when pressure is cut off, and at the same

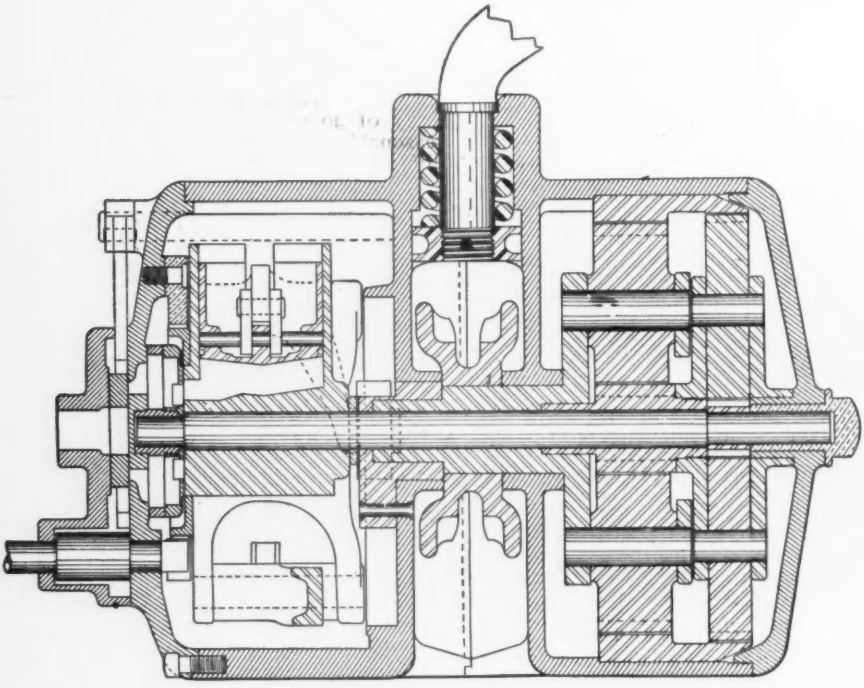


FIG. 2.

the same advantage as the high ratio between the dial and measuring points of the micrometer; in either case an easily-controlled movement of the one part effects the greatest nicety needed for the other part. With a pneumatic motor, during the process of lowering the load, even with the supply hose disconnected and the brake entirely inoperative, if the throttle is released, both the supply and exhaust parts will be closed and a vacuum will be created during one stroke of the piston and compression during the other stroke; the intensity of both the vacuum

time the exhaust and inlet ports are closed. Either of these conditions would hold the load suspended.

The motor used is of the piston type of simple design, consisting of three single acting cylinders radially mounted upon a hub on the driving shaft. Each cylinder carries a bell crank, to one end of which is attached the piston, to the other end a roller, suited to revolve about a stationary eccentric. Air pressure acting upon the pistons successively pushes them outward, causing the rollers to bear forcibly upon the eccentric, just at the time they pass its

highest point. As the rollers under load roll down the incline formed by the eccentric, they propel the cylinders forward in their circular path. Air pressure is led to and exhausted from the cylinders as the ports in the hub rotate alternately past the supply and exhaust openings in the cover plate of the hoist shell. Self-adjusting metallic packings are used in the pistons and on the face of the hub which will keep the parts perfectly air-tight. The bearings are not subject to reversal of stress, hence they do not need adjustment, and are durable and quiet running. Centrifugal stresses, which have been an objectionable feature of motors of this type, are nearly balanced between the piston at one extremity of the bell crank and its heavy arm and roller at the other extremity. The fast running bearings are therefore, practically without load other than that due to the air pressure. Inertia and momentum strains are nearly eliminated, since every moving part of the motor traverses a truly circular path; it, therefore, runs without the least vibration, and adapts the hoist for the most exacting service. In foundry practice, for instance, the entire absence of vibration, either in the motor or gearing is found to be of great advantage. When desired, the hoist is provided with a governor valve which is controlled by the load hook, and which will supply at all times exactly the amount of air required to handle the load, resulting in a decided economy in air consumption. The spur gearing used between the motor and lifting sprocket or cable drum, is compactly arranged in two separate trains; it is enclosed within the

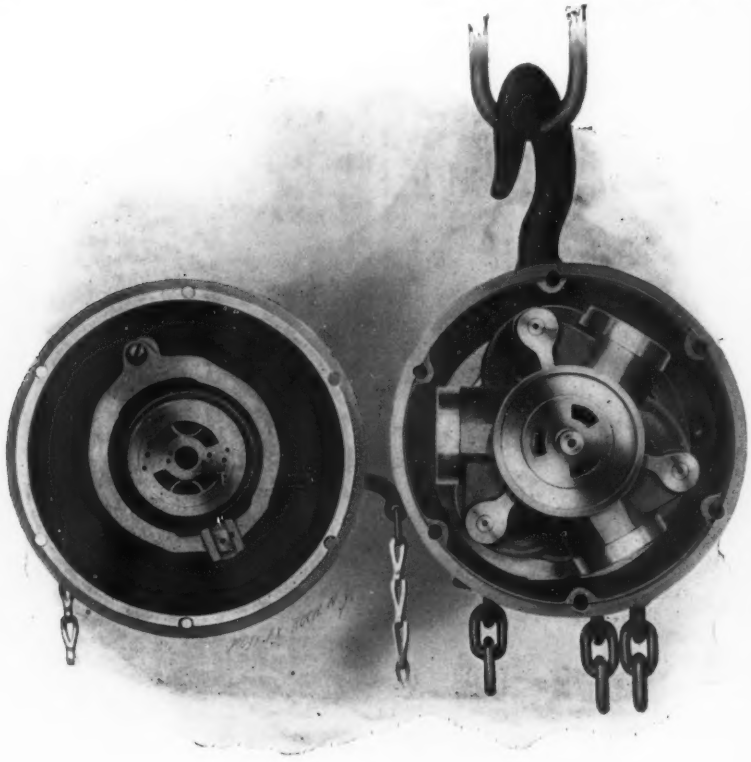


FIG. 3.

hoist shell, and runs in a bath of oil, under conditions the most favorable for efficiency and durability. The motor is also fully enclosed, and runs in a bath of oil; copious lubrication of every running part is, therefore, assured and attendance is reduced to an occasional replenishing of the supply of oil. No oil is ever fed to the motor with the air supply, hence none is ejected from the exhaust opening, and the supply in the motor case is only very gradually consumed. Nearly all the troubles attending the use of the air motor, have probably resulted from the difficulty of securing proper lubrication. It will suffer injury very quickly from want of oil for either its internal or external wearing surfaces. A method by which all wearing surfaces are constantly bathed with oil, without giving the lubricant direct access to the interior of the motor, where it may be carried to the exhaust opening and thus wasted, should effectually prevent injury to the wearing surfaces, and promote as long a life as in any other form of motor. This in connection with the effec-

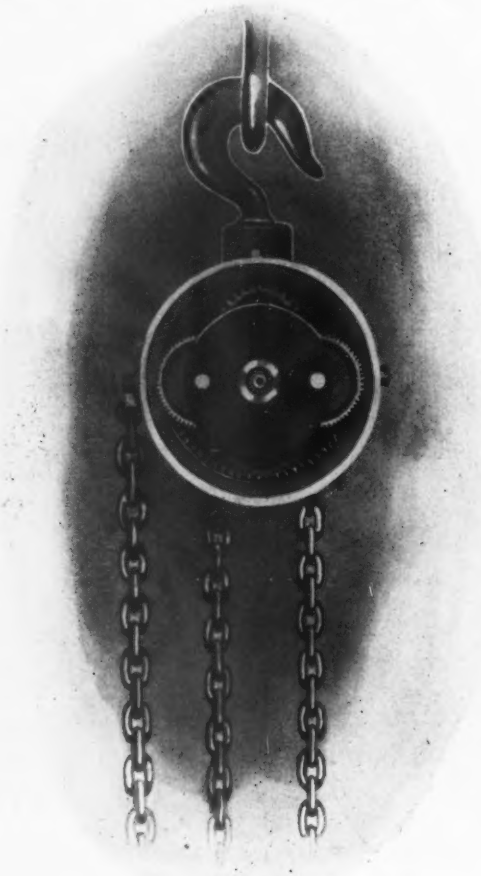


FIG. 4.

tive methods used for packing every part subject to pressure, enables it to retain its efficiency indefinitely.

The Shepard hoists are made in two types; those using a chain running in a sprocket wheel, and those using a wire cable winding upon a drum. The distinct advantage of the chain type is the ease with which an auxiliary high-speed hoist may be provided by attaching a hook to the free end of the chain; the main load hook is then attached to a lower block carried by two strands of the lifting chain, and is used for loads approaching the maximum which the hoist will handle, while the hook attached directly to the free end of the chain and running at double the speed of the block, is used for light loads up to half the capacity of the hoist. In all cases where the sprocket and chain are used, a spring chain guard is provided which effectually prevents the chain from climbing the sprockets, or any jar to the load from movement of the chain in the sprocket; because each link of the chain is firmly seated by the spring guard before it is subjected to any load.

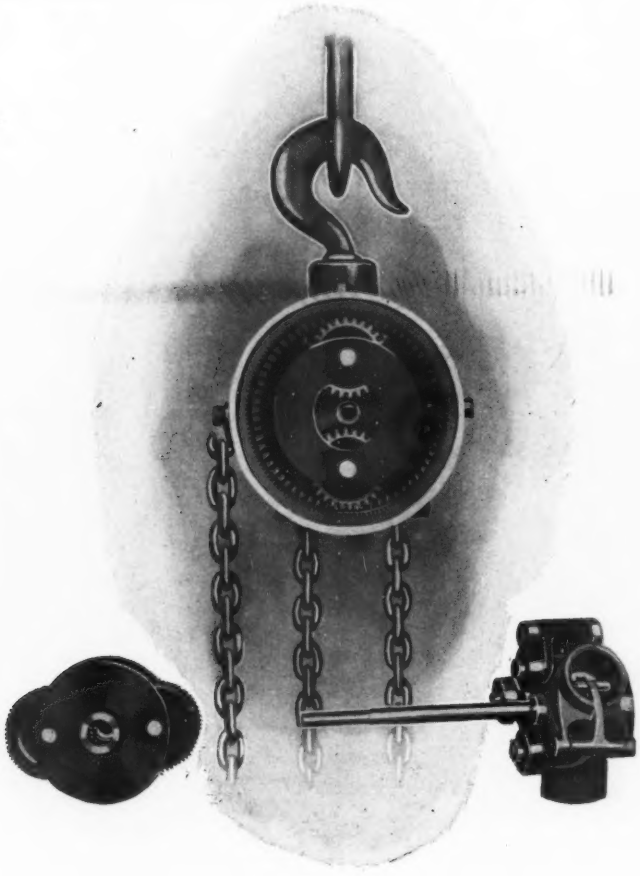


FIG. 5.

Referring to the illustrations; Figure 1

shows a transverse section elevation, through the lifting sprocket, and hook by which the hoist is suspended, showing the spring chain guard and governor spring upon the stem of the hook. Figure 2 is a sectional elevation longitudinally through the entire hoist, showing the motor and its controlling and reversing valve at the left, the lifting sprocket at the center and the hoisting gearing at the right. Figure 3 is from a photograph of the motor in position in the hoist shell, and Figure 4 of the gearing in position in another compartment of the hoist shell. In Figure 5, the component parts are seen removed from the shell. Attention is called to the fact that removal and replacement of all the working parts in either the motor or gearing compartments is practicable without in the least disturbing the adjustment, hence inspection, repair, or renewal of any worn member is possible with the least trouble or delay. Figure 6 illustrates the hoist as seen under working conditions, and shows to advantage its compactness and symmetry of form. It is farther interesting as illustrating one of those few cases in which compactness and symmetry are not obtained at the expense of efficiency and perfect accessibility.

FIG. 6.

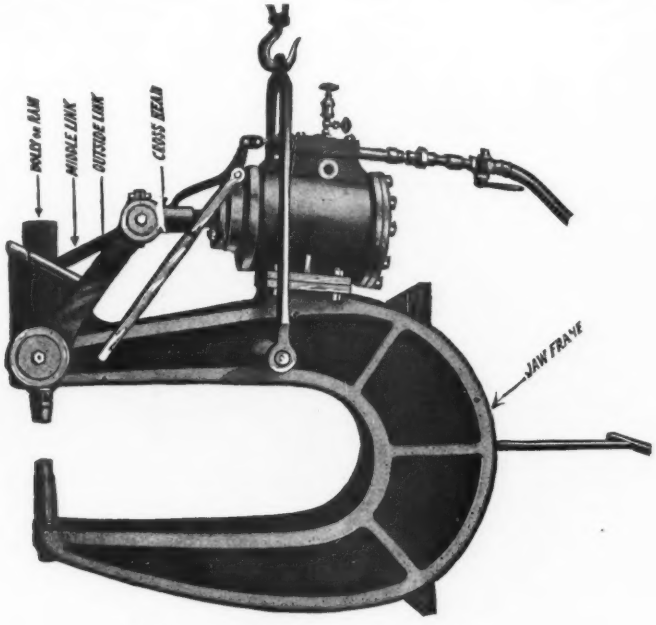
Where conclusions have been drawn in the foregoing, which are not based upon

accompanying proofs, they are only such as appear to be thoroughly established after a careful observation of the hoist under actual and trying conditions.

FRANK A. HATCH.

The Allen Pneumatic Riveters.

John F. Allen, 370-372 Gerard avenue, New York City, was the pioneer in the manufacture of portable pneumatic riveting machines and one is sure to find "Allen" riveters included in the equipment of the leading railroad and other machine shops of the country. The simplicity in construction of these machines, combined with ease of operation, together with the very satisfactory results obtained in their use, has lead to them being widely imitated.



ALLEN PORTABLE PNEUMATIC RIVETER.

A good idea of the standard type of Allen Riveter will be obtained from a study of the engraving presented herewith, which shows a machine with 10-inch cylinder and capacity up to 1-inch rivets. In its construction the piston rod connects levers of different lengths, forming a toggle joint. The lower ends of the larger levers are attached to fixed centers on the frame and the end of the central short lever is attached to the dolly-bar, into the lower end of which the head-tie is screwed. By this latter arrangement any change that is desired in the distance between the dies can be easily effected.

A different leverage is obtained which affords a pressure not found, it is claimed, in any other riveter, patent rights on which were granted Mr. Allen. There is also a patented cut-off contrivance which prevents any possible leakage of air. The dolly-bar acts in a direct line with the axis of the rivet. The capacity of the Allen riveters is guaranteed and riveters with 8-inch cylinder will handle rivets up to 5/8 inch; 10-inch cylinder, 1-inch rivets and 12-inch cylinder, 1¼-inch rivets. The machines are balanced and when hung up may be operated in either a vertical or horizontal position. Lugs are furnished with all sizes above 25-inch reach, by means of which

they may be fixed in position as stationary machines. All Allen riveters may be operated by steam or compressed air, and it is stated are much lighter in weight than any other machines that are built for the same work.—*Railway Master Mechanic.*

Compressed Air for Pumps.*

The following inquiry has come to me: Will you please give us the best and shortest rule you know for determining suitable sizes for air compressors for operating pumps? We often have to figure on the sizes of air compressors for pumps at various distances from the compressor and from the tank, at different elevations and also at different pressures. Take, for example, the following: What size air compressor will be required to deliver 60 gallons of water per minute against a head of 150 feet? The pump is 1,000 feet from the compressor and 3,000 feet from the tank or reservoir; air pressure 80 pounds, gage. We would like to get the shortest rule that would fit a case of this kind. We have a rule to compute the size of the compressor, but are asking for one that will answer our purpose better.

If anyone has a "rule" for a case of this kind he is to be congratulated; I don't know any, and I don't know how one could be made. The mode of computation in the case should not be any finer than the data, so it would be quite rough. Two very essential particulars would be the size of pipe permissible and the style of pump employed, neither of which is given. I assume the pipe to be of adequate size and that an ordinary steam pump is used, such being the common practice and no other being suggested. Now a gallon of water = 231 cubic inches, or .1337 cubic foot, and .1337 × 60 = 8.002 cubic feet of water delivered per minute. The head equals 150 × .434 = 65.1 pounds. As the air pressure maintained is 80 pounds, we may assume that if the air and the water cylinders of the steam pump are of equal diameter the excess of air pressure over the water head may be sufficient to keep the column in motion, and that a volume of air equal to the volume of water, or 8.022 cubic feet of air at 80 pounds, will be required. There are leakages and usually unaccounted-for losses to be made up and the clearances, which in a steam pump are enormous, to be filled, so that 50 per cent. at least should be added to the above, making, say, 12 cubic feet of free air per minute at 80 pounds pressure required. 80 pounds gage, or 94.7 absolute, = 6.45, say 6.5, atmospheres, so that 12x6.5 = 78 cubic feet of free air per minute required. The air volume is taken at normal temperature, as that of course is the temperature of the air as it enters the compressor, and the compressed air also will have cooled to near the same temperature by transmission through the 1,000 feet of pipe. No account is taken of the air pipe friction in this transmission, as it would not be appreciable if the pipe was of suitable size.

It may be worth while to note the power at each end of the operation here considered: 60 gallons × 8 1-3 pounds per gallon × 150 feet = 75,000 foot pounds, and 75,000 ÷ 33,000 = 2.27 horse-power. We found that 78 cubic feet of free air per minute would be required at the compressor. To compress, without cooling, 1 cubic foot of free air per minute to, say here, 85 pounds pressure requires .1655 horse-power (Richards' "Compressed Air" Table V), then 78 × .1655 = 12.9 horse-power. This represents an efficiency of 2.27 ÷ 12.9 = .176. If they will use steam pumps and uneconomical air compressors this is the result to be expected and which is quite commonly attained. When I first began to know something of the practical use of compressed air I encountered such results as this and was naturally disgusted, but I was compelled to accept them, and no satisfactory progress seems to be making toward better general economy with compressed air for pumping.

*By Frank Richards in the *American Machinist.*

This article, in the *American Machinist*, evoked a communication on the subject from E. A. Rix, of San Francisco, in which he said:

"Replying to the article on 'Compressed Air for Pumps,' by Frank Richards, we have to suggest that a rule which might suit your correspondent would be as follows: The mean of a great many experiments with direct-acting pumps using compressed air at 90 pounds pressure in the main, shows that a cubic foot of free air compressed to 90 pounds will yield 135 foot-gallons of work, and that inasmuch as the air in direct-acting pumps is used practically

at full pressure, the relative work which may be done by air at 80 pounds would be in the proportion of 80 to 90. This being the case, the problem which you present, viz., 60 gallons per minute, 150 feet high, would represent 9,000 foot-gallons. Dividing by 135, it would require 66 6-10 cubic feet of free air compressed to 90 pounds, and at 80 pounds would require 66 6-10 times 90 divided by 80, or 75 cubic feet."

In the following issue, another communication regarding the same article appeared from F. M. Leland, of the Risdon Iron and Locomotive Works. He referred to the original article and submits a catalogue giving tables for pumping plants. He said:

"Mr. Richards figures that to pump 60 gallons of water per minute, 150 feet high, would require 78 cubic feet of free air per minute. His figuring is all right, with the exception that we think that 50 per cent. is a little too much to add. For instance, take our table and take the ratio of diameters as he gives them, viz., air and water cylinders the same size, run this line out until you come to 150 feet head, and you will note that it requires 1.04 cubic feet of free air per gallon of water pumped. Multiply this by 60 and the result is 62.4 cubic feet.

"The actual amount of free air required, according to Mr. Richards' article, would be, say, two-thirds of 78, or 52 cubic feet. If he would add about 20 per cent. to this instead of 50 per cent., this would give him what our table says is the correct amount. We have used these tables quite frequently and found that they are fairly correct.

"We note the concluding paragraph in Mr. Richards' article, in which he comments on the uneconomical conditions of pumping water with compressed air. In this connection we would say that there are many conditions in the mining countries where economy cuts but very little figure. For instance, it often happens that a mine is located 200 or 300 feet up the hill from a large stream. These large mountain streams have a very rapid fall, often 300 or 400 feet in a mile; it is a very simple matter to go back half a mile or so and catch up 400 or 500 inches of water, run it along the hillside in a flume or ditch to a head box and run it down the hill in a pipe to get 200 or 300 feet head. You use this on a tangential water wheel and operate a belt-driven or direct-driven compressor. In most cases the water is free of cost and the compressor is geared to run a certain number of revolutions, and when the pressure gets up to a certain point it blows off and goes to waste.

"Mr. Richards also speaks of the wastefulness of the ordinary steam pump. This is a recognized fact in the mining world, but if ever Mr. Richards worked at the bottom of a 200 or 300 foot shaft with a steam pump for a companion he would be apt to bless the man who invented compressed air. Not only does a steam pump heat up the atmosphere and spoil the air, but when you are lowering it and setting it in a new position the handling of the hot pump breeds profanity. There are many things to be said in favor of the much abused steam pump, although economy is not one of them."

At the close of this communication the following comment was editorially made:

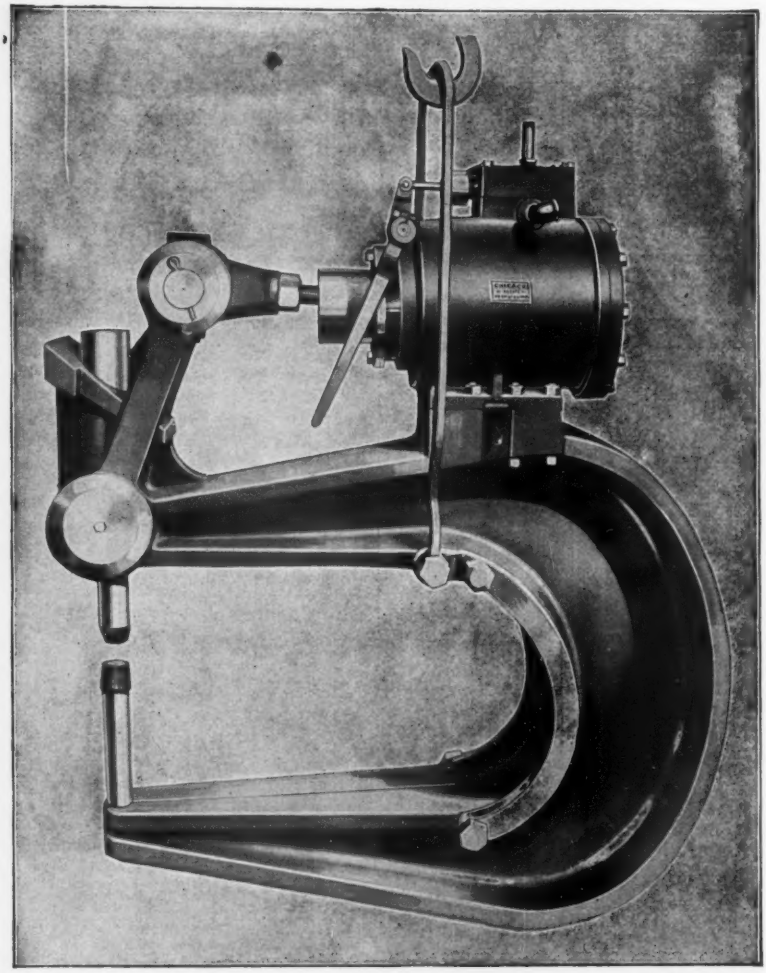
"[There is an interesting discrepancy here between the figures of Mr. Rix and those of Mr. Leland. Those of Mr. Rix come so near to my result as to be a practical confirmation of it. My way of computing and my allowance for the uncertainties which are certain to exist come from actual experience, when for a few years I was in a position where it was quite desirable for me to make out as good a case as possible for compressed air. I never in practice saw such high economy as Mr. Leland figures out, and if he has reliable practical evidence to back him he has good stuff to advertise.

"In speaking of the waste in the use of compressed air in pumping, I distinctly do not therefore in any case advocate the use of steam instead for pumping mines or shafts or tunnels. Of course, the air is generally incomparably preferable. What I do object to is *the use of the air in the ordinary steam pump*, with its enormous clearances to be filled and its lack of all means of using the air expansively, when it would be such a simple matter to produce a pump with a crank movement which would give a small and constant clearance, and with some cut-off or other expansion gear. When such a pump is used for the pumping I will cut a big chunk off the 50 per cent. allowance, which otherwise I still think necessary.—FRANK RICHARDS.]"

Compression Riveter.

The Chicago Pneumatic Tool Company's compression riveter (see illustration) is made in two sizes, Nos. 1 and 2. The No. 1 weighs 1,900 pounds, has 30-inch reach, 16-inch gap and capacity up to ¾-inch rivets, inclusive. The No. 2 weighs 2,275 pounds, has 36-inch reach, 20-inch gap and capacity up to 1-inch rivets, inclusive.

These machines are designed principally for structural work and are in general use throughout the country, giving excellent results. The principal parts comprised in its construction are a cylinder, toggle joint, plunger and frame. The piston rod connects two levers of different length, forming the toggle joint; the lower ends of the larger levers are fitted to trunnion bearings on the frame, and the end of the short lever is fitted to a bearing block in plunger. The die holder is screwed into lower end of plunger, by which arrangement any desired change in the distance



COMPRESSION RIVETER.

between the dies is easily effected. The plunger has 3½-inch stroke and acts in a direct line with the axis of the rivet. The machine is balanced in any position and hung by a bail, enabling the operator to turn it in any direction with slight effort.

Compressed Air Pump for Painting.

A portable compressed air pump for painting, whitewashing and spraying has been placed on the market by the Humphryes Mfg. Co., Mansfield, O. The accompanying illustration shows the machine equipped with a 3 in. hand air pump, a galvanized iron tank, 8 x 30 in., for storing air, and another tank of the same material, 12 x 30 in., for the liquid, whatever it is. The smaller tank is filled with air from the pump. After the large tank is filled with liquid and the valve closed between the funnel and the tank, the valve between the two tanks is opened, allowing the air to pass into the larger one through a pipe extending to the bottom. When the gauge of the air tank registers 40 lbs. pressure all liquids, it is claimed, can be exhausted from the tank without further use of the pump. The machine is easy to transport, can be operated by one man, and the chief claim for it is that it is economical and very simple to operate.

COMPRESSED AIR PAINTING MACHINE.

The Edwards Simplex Air Sander.

FOR USE ON EITHER LOCOMOTIVE OR STREET CARS.

The accompanying line drawing shows an upright sectional view of the trap. that they have many points of advantage over other styles of sanders now on the market, viz.: The nozzle is always buried in the sand and pointing toward the opening it readily discharges the sand over the bridge where gravitation along with the blast carries it to the rail. It

FIG. 1.

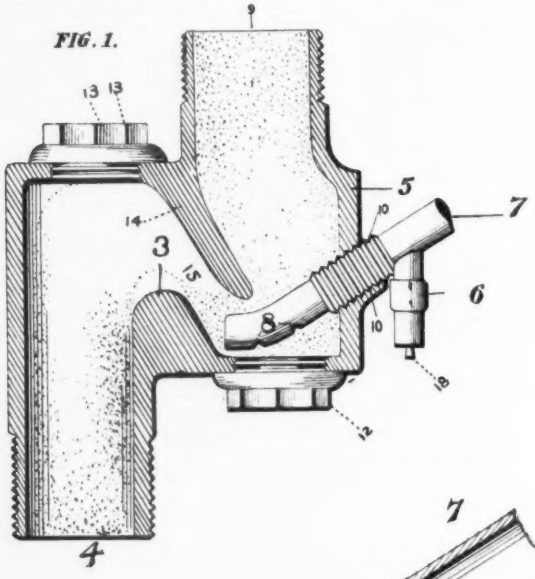
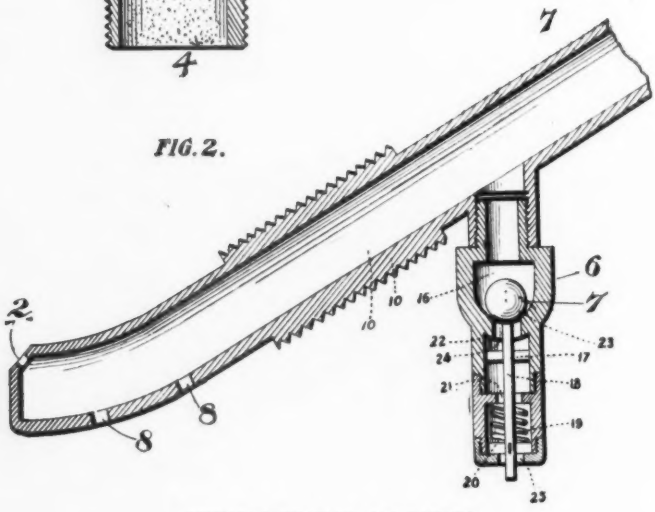


FIG. 2.



EDWARDS SIMPLEX AIR SANDER.

These sanders have been in use for some time on the P. and L. E. R. R., and it is claimed by the motive power officials can be readily seen that it does not require but a small amount of air to operate this device as the sand cannot cake

or pack in the trap, it is guaranteed by the inventor and manufacturer to put sand on the rail as long as there is sand in the box and trap. The inventor and patentee of this device is F. H. Edwards, proprietor of the American Metallic Packing and Supply Co., of Cleveland, O., who are placing it upon the market. —*Railway Master Mechanic.*

Allier's Air Painting Machine.

The Allier painting machine, an illustration of which is shown herewith, is designed to meet the requirements of railways for rapid, economical and efficient painting of stations, woodwork in general and repainting of cars. The machine is a recent invention and is manufactured by the C. L. Bastion Mfg. Co., 76-82 Illinois street, Chicago. The manufacturers claim it has given most excellent results, the same having been evidenced by the demand for the machine. Among the points in which it excels, it is claimed that it uses only one-third of the amount of paint used by other white-washing machines. It gives a satin finish with no streaking, and one machine will do the work of ten men with brushes. It is so constructed that the paint and air meet at the outlet, forming a fine spray. The trouble with white-washing machines has been that they squirt the paint instead of spraying it. This deficiency has been met by the Allier machine, which is found to spray the liquid effectively. The Allier machine is operated at 90 pounds pressure for thin mixtures on rough surfaces, and for thick mixtures on smooth surfaces the pressure required is 100 to 110 pounds. The nozzle of the machine is held from 12 to 15 inches from the work, and so held as to strike the surface squarely. It is claimed that this is the only machine that successfully handles cold water, oil, mineral or graphite paint. The tests made show that the cost of two coats of paint by means of this machine is one-third the cost of two coats by hand.—*Railway Master Mechanic.*

ALLIER'S AIR PAINTING MACHINE.

The Diamond Sand Blast.

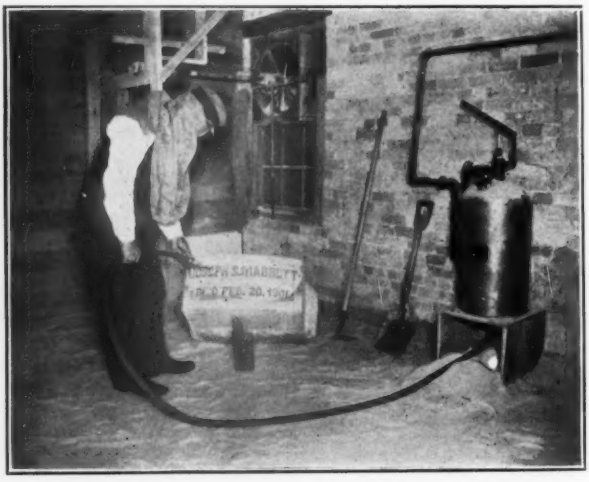
After careful experimenting, note of which has been made from time to time in COMPRESSED AIR, the Shaver Sand Blast Machine, known as the "Diamond Blast," has been perfected and is now on the market. It is controlled by the American Diamond Blast Co., with New York offices in the *Times* Building, 41 Park Row.

The original idea of the sand blast was suggested by nature, the wind picking up little grains of sand and grinding away the rocks against which they were hurled. The first machine was a hand-throwing machine. This was followed by the air blower, which was really the first practical machine. While large volumes of air and sand were required, only comparatively low pressures could be produced even with the use of great power.

The next step was the introduction of compressed air, which revolutionized the sand blast, for while increasing the pressure it reduced the horse power and sand required. The early machines, however, were large, cumbersome and complicated and even those working with compressed air were only able to operate at from 10 to 30 pounds with a maximum possibly of 40 pounds to the square inch.

The "Diamond Blast" is the result of some of the latest improvements in this class of machinery and will work anywhere from 10 to 250 pounds pressure to the square inch. It is generally considered, however, that the most desirable pressure is from 50 to 80 pounds. The "Diamond Blast" uses a hose and nozzle of smaller diameter than has heretofore been the custom. The advantage claimed for this change is the use for a greater pressure with a less expenditure of power and a smaller amount of free air. The machine is so arranged so that the operator can control both the volume of air and the amount of sand or other abrasive material he desires to use. This permits the use of different quantities of sand according to the requirements of the work. The operation is very simple. There is a valve which controls the air and a lever which regulates the flow of sand. To discontinue the operation it is merely necessary to lower the lever and turn the valve.

Being of simple design the machine can be taken apart and put together again in a short time with, it is said, but little trouble.



THE DIAMOND SAND BLAST.

In construction, the tanks are made of steels and of first class material, galvanized inside and outside. Other parts are made of brass, thereby preventing oxidation should any moisture reach them.

It is claimed that the action of the "Diamond Blast" is not abrasive, cutting or grinding in the usual meaning of these terms. It is true pulverization by the successive impact of the grains of flying sand. The operation consists of throwing a stream of rapidly moving sand against the object to be operated upon. As each grain acts alike the abrasion resulting from the hole is uniform in depth and texture of roughness.

The action is extremely rapid; momentarily depolishing glass; instantly changing the previously bright surface to obscure or ground glass, a little longer cuts deeper and in a very short time apertures are readily pierced through sheet and plate glass. Granite, stone, marble and slate are just as amenable to its action.

Iron, steel and other metals have their surfaces easily smoothed, reduced or coarsely granulated, according to force and abrasive power used.

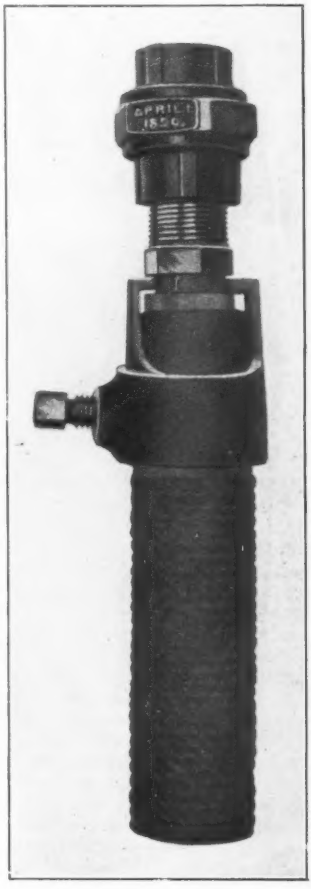
The abrasive need not be harder than the material to which it is applied, as the hardest steel, corundum or carborundum are readily pierced with sand.

The energy contained in a single flying grain of sand is small, even while traveling at a great velocity, but it is the very small area upon which this is expended that makes cutting by it possible.

Sand averaging 1-50 inch in diameter and propelled by a pressure of 40 pounds to the square inch, will cut granite most rapidly. Such sand grains will weigh .005 grain and will be moving 500 feet per second, and will contain about .00176 foot pound energy. This energy, distributed over the area of impact which is .00000004 square inch, is at the rate of 440,000 foot pounds per square inch. (Hiscox.) The action of the blast is different in granite, iron and glass, though the effect produced is not only the desired one, but without parallel.

Steam and Air Hose Couplings.

While a small detail, perhaps, the importance of successful steam and air hose couplings cannot be overestimated. They play a very important part in the successful installation of mining machinery and now that some of the larger questions have been solved, inventors are turning their attention to these details and are simplifying these and other appliances



GIBBONS HOSE COUPLING.

which are used in the operation of the mine.

One of the newest is the Star steam and air hose coupling, the invention of W. A. Gibbons. The principal features claimed for it are easily determined, a saving of repair bills, and strength and saving in

first cost. Many couplings used have had clamps that were hard to place on the hose, requiring the use of a vise to adjust them. No vise is necessary for this kind. With the Star coupling a common union is all that is necessary, where in other cases a special one belonging to the coupling itself must be replaced by one of the same kind.

It is further claimed that this new coupling can be attached in 80 per cent. less time than any other one now in use. McNeil & Co., of Joplin, Mo., are the owners of the patents.

Notes.

The Compressed Air House Cleaning Company of Southern California has been incorporated in that State, with a capital stock of $75,000. The directors of the concern are Wm. M. Garland, Harry Gray, Clarence A. Miller, W. C. Norman, Hulett C. Merritt.

The Wisconsin University, located at Madison, that State, is soon to have a compressed air storage water supply system which will not only supply the university, but the State capitol building as well. Note has already been made that such installation was intended. It is now said the work will be started this summer and hurried to an early completion.

The advantages of a steady blast, easily controlled, have finally induced several manufacturers of window glass to try machines for blowing glass by compressed air. The experiments now under way have been quite generally satisfactory. If the new method does all that is promised it will soon displace the present process of glass blowing, which is slow, costly and very wearing on the health of the men.

The amount of air required by a rock drill depends much on the make or design. It is commonly estimated that a 3-inch drill will consume about 15 cubic feet of air per minute, compressed to a pressure of 60 pounds. A 3½-inch drill will use about 20 cubic feet per minute. These figures, which are about a general average, may be used for choosing a compressor which is to operate drills at sea level.

Among the deaths recorded during the last month was that of Mr. E. G. Patterson, a well-known engineer and railroad man of Titusville, Pa. Mr. Patterson invented a method of track ballasting by compressed air, which was illustrated and described in a previous number of COMPRESSED AIR. He was an old subscriber to COMPRESSED AIR, and contributed several interesting articles to this publication.

A newcomer in the field of compressed air machinery is the Pilling-Kruse Air Engine Works, Bucyrus, O., which concern has gone into the manufacture of compressed air hoisting engines for all purposes, both stationary and portable, and for any height of lift. The claim is made that it can be so constructed that the hoisting rope will not ride and that the requirements of speed will be met with. The new factory of the concern, a two-story structure, has just been completed.

Thomas Chalmers, one of the founders of the firm of Fraser & Chalmers, constituent part of the Allis-Chalmers Company, died at Chicago July 13. Mr. Chalmers came to America from Scotland in 1843. He had a part in building Chicago's first water works, a single pump at the foot of the river; installed the first steam heating apparatus in the city, that in the old Dearborn school, and was one of the engineers of the old Illinois and Michigan Canal.

There are few readers of COMPRESSED AIR who have not heard of the International Correspondence Schools of Scranton, Pa., whose courses by mail have proved so uniformly successful. An addition has been made to the already extensive curriculum, which consists of a course in advertising. The International Schools have long been famous for their up-to-date advertising methods, and they now propose to teach other people how to be equally successful. While the advertising course is principally adapted for retail advertising, it will undoubtedly be of considerable value to those connected with large manufacturing concerns.

It is reported that liquid air is finding some commercial use in Berlin, and can

be secured two litres (0.528 gallons) at a time for about 30 cents American money. It is said that the receptacles for delivering it are made of glass with double walls, the space between the walls being filled with an insulating material, the walls being silvered to prevent radiation of heat, and the whole enveloped with an insulating material. They retain their temperature for 14 days. Remembering that a drop in a glass of water will produce freezing, it is reported that it will be utilized for refreshing drinks and improving the condition of the air in the sick room.

Some interest has been aroused by the statement made in the daily papers telling of the incorporation of the New York–Buffalo Air Car Railway at Newark, New Jersey, with a capital stock of $125,000, of which $1,000 is paid up. The incorporation papers were drawn by James B. Dill, a New York corporation lawyer, and were filed at the office of the County Clerk of Essex County by the New Jersey Registration and Trust Company of East Orange. Neither Mr. Dill nor the East Orange Company will have anything to say about the plans. It is generally reported that the company will operate an air line railway between New York and Buffalo under patents taken out by Dr. Adolph Brodbeck, of Salt Lake City. According to the daily papers, the motor power will be compressed air, and the cars will be run on a steel rail at a speed of 95 to 100 miles an hour.

Among recent sales of street railway apparatus, the Westinghouse Traction Brake Company reports an order from the Los Angeles Railway Co., Los Angeles, Cal., for 80 street car air brake equipments with motor driven compressors. These equipments are to be fitted to new high speed cars which are being built by the St. Louis Car Company.

The Westinghouse Traction Brake Company has also lately closed contracts for the following motor driven compressor air brake outfits:

Sixteen to Oakland Transit Company, Cal.

Seventeen to North Shore Railroad Company, San Francisco, Cal.

Twelve to Indianapolis and Northwestern Traction Company.

Sixteen to Indiana Railway Company, South Bend, Ind.

With compressed air taking such a prominent part in the construction of the Rapid Transit tunnel in New York, all sorts of methods have been tried with more or less success to increase the efficacy of the compressed air machinery required. A portable air compressing machine plant was built at the De La Vergne Refrigerating Machine Co., and used continually in one section of the tunnel. It proved quite satisfactory in various instances, especially for compressing air for pneumatic tools. The outfit consisted of a Hornsby-Akroyd oil engine geared to a slow speed air compressor and placed on a strong steel frame with four substantial road wheels. Attached to it was a patented cooling water apparatus by the use of which only 30 to 40 coolers of water were required to operate the engine for the whole day, and practically no water was consumed. The air receiver was placed in the bed of the truck while the oil tank was fitted inside the frame.

In shaft sinking or small tunnels, columns with an adjusting screw at one end only are generally used. One drill is mounted on each by means of a special clamp that permits the drill to be adjusted so as to put in a hole at any height or angle. In larger tunnels a column with an adjusting screw at each end is employed, with one or two swinging arms, on which the drills are mounted. Just below the arm it is customary to place a safety clamp, which enables the arm to be loosened and swung to one side to change the bits and then swung back without losing the alignment. An arm cannot be used with the single-screw column, because its leverage will turn the columns and work the drill out of line. Allowance must be made in setting up the columns for 8 to 12 inches of blocking under the screws, as they will not work without it. The screws should be worked short, using blocking so far as possible, as this gives greater stiffness without liability to work out of alignment. Shafts up to 8 feet in depth, unless in very hard rock, should not use more than one drill on a single-screw column.

Two new circulars have been received from the Chicago Pneumatic Tool Company. These are advance sheets of a new catalogue. One is devoted to pneumatic drills. It illustrates Little Giant drills, flue-rolling, reaming, tapping, wood-boring machines and the Boyer piston air drill. A number of attachments for the drills are also shown, such as angle gears, flue cutters and flue expanders. The pamphlet closes with a statement of results of tests made with these machines, which illustrate their advantages over hand work. The other circular illustrates and describes pneumatic hammers and riveters. It includes valuable tables illustrating the possibilities of reducing the cost of work by their use. Such records are very seldom seen in catalogues. We have also just received special circulars Nos. 38 and 39, illustrating various types of pneumatic tools, with views of the tools at work. Special attention is directed to applications of the Boyer drill and "jam riveter," a new method for cleaning locomotive crown sheets with the riveter and of applying the Boyer drill to a yoke similar to those used in riveting. These are important functions of air tools believed to be entirely new, and are sure to find a good reception in locomotive shops.

The new electric motor cars of the Central London Railway (underground), which take the place of the separate electric locomotives formerly used in the operation of the line, have a motor truck at one end only. The cab covers the entire length over this truck, behind which the steel underframe is dropped low to receive the body of the car. The cab is 9½ feet long and 6½ feet wide over the frames, while the width over axle boxes is 7 feet 2½ inches. The wheels are 34 inches diameter, with a wheel base of 6 feet. With a current of 200 amperes at 500 volts, each motor is designed to give a tractive effort of 2,500 lbs. at the rail, and a speed of not less than 18 miles an hour. At 80 amperes and 500 volts the tractive effort is 650 pounds and the speed 27 miles an hour. The gear ratio is 1 to 4, with cut steel gears. There is a motor-driven air compressor, with a capacity of 35 cubic feet of free air per minute compressed to 90 pounds pressure in a main reservoir of 8 cubic feet capacity. When the pressure reaches 90 lbs. the motor is automatically cut out, but the circuit is closed again when the pressure has fallen to 80 pounds. The Westinghouse quick-acting brake is used, and a hand brake is also fitted. There are 22 lamps on the car: 14 in the passenger compartment, 1 over the rear platform, 3 for the instruments in the cab, 1 in the switch compartment and 2 in the headlight. The two latter of 32 c. p. and the others are of 16 c. p.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz.: all communications should be written on one side of the paper only; they should be short and to the point.

Editor COMPRESSED AIR:

We have no objection to giving you the facts regarding the explosion which wrecked the discharge chamber of one cylinder of our 20¼-inch by 24-inch duplex air compressor.

The accident occurred through error in judgment on the part of one of our employes in endeavoring to cut off one cylinder and use only the other as a single compressor.

In his endeavor to accomplish this he closed the discharge or outlet valve while the machine was running.

We roughly estimate that the pressure reached 800 pounds at the time the casting gave way.

The iron appeared at the fractures to be of good grade and flawless.

Yours very truly,

FREMONT CONSOLIDATED MINING CO.
(Signed) ARTHUR GOODALL,
Manager.

[We presume that when Mr. Goodall states that his employe closed a discharge or outlet valve he means that he closed a throttle in the discharge pipe which leads from the discharge valve to the air receiver. It is impossible to close the dis-

charge or outlet valves on a compressor, as they open and close automatically. This explosion resulted in the death of Mr. Paddington, the superintendent.—ED.]

Death of Mr. James Cooper.

With the death of Mr. James Cooper at Montreal, on Saturday, July 11, a prominent figure in the manufacturing circle of Canada passed away. As president of the James Cooper Manufacturing Company, which concern represents the Ingersoll-Sergeant Drill Company in Canada, Mr. Cooper was prominently identified with the air compressor and mining machinery interests of the Dominion. His death came after a three weeks' illness and just before the arrival of his wife, who had been hurriedly summoned from a trip through Europe. Mr. Cooper was 68 years of age.

He began his business career with the firm of Rice, Lewis & Co., of Toronto, and later went with Frothingham & Workman, in both instances traveling for them. He associated himself in 1872 with Mr. Fred Fairman, under the firm name of Cooper, Fairman & Co. While they dealt chiefly with heavy hardware at the start, they gradually became interested in manufactures and were pioneers in the manufacture of barb wire. This was gradually developed, until a distinct corporation, under the name of the Dominion Ware Manufacturing Company, with Mr. Cooper as president, was organized. On the same line was the Dominion Wire Rope Company, of which Mr. Cooper was also the president. Another branch company, for the manufacture of patent pipes and elbows, was headed by Mr. Cooper. An extensive business in compressors and mining machinery was gradually built up, and the James Cooper Manufacturing Company organized to control it. The firm of Cooper, Fairman & Co. was dissolved in 1889, but Mr. Cooper retained his interest in the various manufacturing firms, besides doing a very large general railway supply business, representing a number of prominent American and British manufacturing concerns.

He was a man of noble character,

MR. JAMES COOPER.

beloved by his associates and held in high esteem as one of Montreal's highest citizens. His manner to everybody was uniformly courteous and considerate. Being a man of means, he was liberal in his distribution of charities, giving freely, but in so quiet and unostentatious a manner that his name seldom appeared. We understand that after providing liberally for his widow Mr. Cooper has left his entire fortune to charity.

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U.S. PATENTS GRANTED JUNE, 1903.

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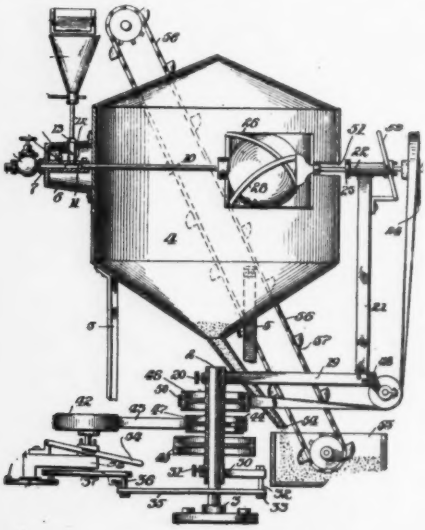
731,812. SAND-BLAST. John Perdew, Monaca, Pa., assignor of one-half to Harvey Strong, Coraopolis, Pa. Filed June 4, 1902. Serial No. 110,223.



A device of the character described, the combination of a body portion having sand-blast pipe arranged on the interior thereof with a suitable source of sand connected to said pipe, a means for actuating the sand, a work-holder within said body supporting means for the same, means carried thereby for rotating the work-holder, means for oscillating the work-holder, and means for operating simultaneously said oscillating and rotating means.

732,375. FLUID-PRESSURE BRAKE APPARATUS. Joseph Reichmann, River Forest, Ill. Filed Aug. 18, 1902. Serial No. 120,025.

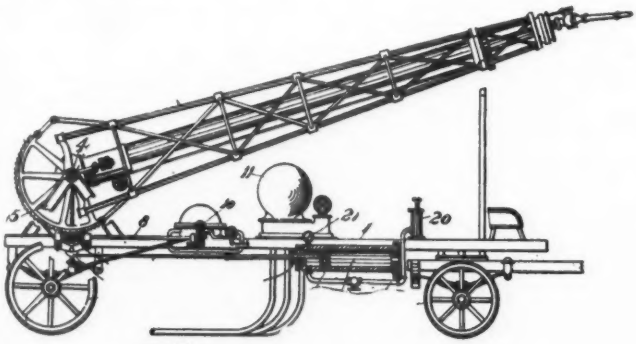
A fluid-pressure brake apparatus, the combination with appliances adapted to charge the brake-cylinder with air pressure from the auxiliary reservoir and to charge the brake-cylinder with air pressure from the main reservoir independently of the auxiliary reservoir, and to exhaust the air from the brake-cylinder through an independent passage leading directly to the atmosphere, and a single line of pipe connection, of a main reservoir, a train-pipe and a valve device interposed between the main reservoir and train-pipe and adapted to govern the supply of air pressure from the main reservoir to the train-pipe.

731,772. PNEUMATIC RIVET-HOLDER. Elias Gunnell, Chicago, Ill., assignor of one-half to W. Irving Babcock, Chicago, Ill. Filed June 20, 1896. Serial No. 596,293.

731,772.

A portable pneumatic holder-on for riveting, adapted to be interposed between the work and a support or abutment, and consisting of a pneumatic cylinder, a piston in the form of a rod projecting from the cylinder, and provided with a rivet-holding head at its extended outer end, means for admitting and releasing air near the rear end of the cylinder, and a detachable section on the rear end of the cylinder, the construction and arrangement being such that the tool is adapted to be held in position alone by the pressure of air in the cylinder.

731,889. AUTOMATIC PNEUMATIC BALANCE FOR WATER-TOWERS OR THE LIKE. Henry H. Gorter, San Francisco, Cal., Filed Sept. 11, 1902. Serial No. 122,910.



731,889.

An automatic pneumatic balance for water-towers and the like, the combination of a compressed-air cylinder, a piston operated thereby, a piston-rod therefor, a swinging tower operatively connected with said piston to move the same to compress the air in said cylinder by the descent of the tower, and means, independent of the compressed-air cylinder, for elevating said tower.

730,121. UNLOADING MEANS FOR AIR-COMPRESSORS. Ebenezer Hill, Norwalk, Conn. Filed Nov. 12, 1902. Serial No. 130,956.

A multiple-stage compressor, the combination with cylinders operating at different pressures, of an escape-valve controlling an outlet from the duct between the cylinders, a communication between the system beyond the high-pressure cylinder and said escape-valve, whereby the escape-valve is moved to open the outlet from the interduct when the pressure in the system beyond the high-pressure cylinder exceeds the predetermined maximum, and a valve controlling an opening into the high-pressure cylinder and adapted to be rendered inoperative by the drop of pressure resulting from the opening of the escape-valve.

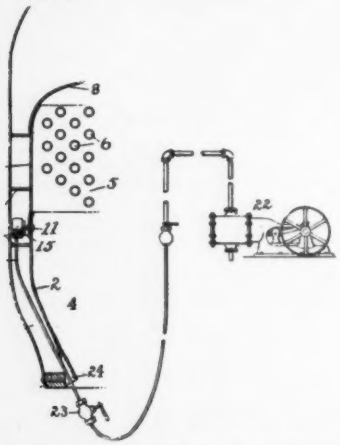
730,474. PNEUMATIC TIRE. Edwin B. Rayner, Piqua, Ohio. Filed Oct. 30, 1902. Serial No. 129,456.

730,315. TRIPLE VALVE. Paul Synnestvedt, Pittsburg, Pa., assignor to the Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Oct. 17, 1902. Serial No. 127,724.

731,314. PNEUMATIC LIFE-BELT. Johan A. Malmqvist, Campello, Mass. Filed Aug. 20, 1902. Serial No. 120,373.

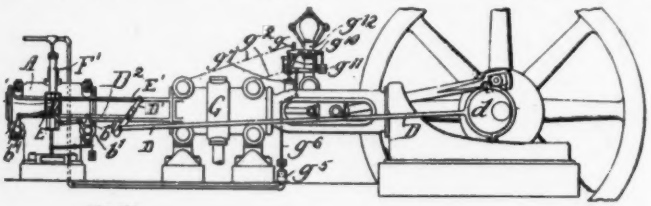
729,947. PNEUMATIC STACKER. Charles N. Leonard, Indianapolis, Ind., assignor, by mesne assignments, to the Indiana Manufacturing Company, Indianapolis, Ind., a Corporation of West Virginia. Filed Feb. 16, 1903. Serial No. 143,658.

730,207. PNEUMATIC TOOL. Dennis G. Foley, Hartford, Conn. Filed Aug. 29, 1902. Serial No. 121,489.



A combination, a comparatively short base or support having the greater part of its interior surface threaded, a comparatively short casing having the greater portion of its outer surface threaded to fit the thread in the base, and having a pressure-chamber, an anvil projecting within the pressure-chamber and a fluid connection for admitting a pressure medium within said chamber.

731,692. AIR-COMPRESSOR. George de Laval, Cambridge, and George P. Aborn, Boston, Mass., assignors to The Geo. F. Blake Mfg. Co., New York, N. Y., a Corporation of New Jersey. Filed July 25,1901. Serial No. 69,638.



731,692.

An air-compressor, the combination of inlet-valves each having a stem, a disk fixed on each stem, and having a plurality of notches or projections, levers upon said stems provided with means for temporarily engaging the notches or projections and operated from the eccentric of the engine to move each disk in one direction, and a device operated from said eccentric and controlled by the varying pressure of the air compressed, and connected for positively and variably moving the disks in an opposite direction, in accordance with the variations of air pressure, to close said valves.

731,234. AIR-BRAKE VALVE MECHANISM. Edward G. Shortt, Carthage, N. Y., assignor to the International Air Brake Company, Jersey City, N. J., a Corporation of New Jersey. Filed Apr. 16, 1900. Renewed Mar. 14, 1903. Serial No. 147,865.

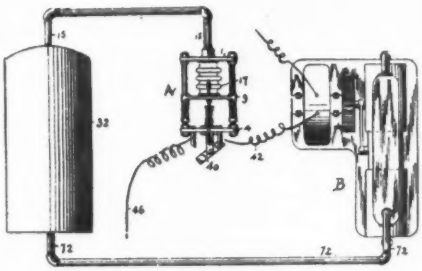
730,565. PNEUMATIC-ACTION FOR MUSICAL INSTRUMENTS. Johann D. Philipps, Frankfort-on-the-Main, Germany. Filed Nov. 28, 1902. Serial No. 133,128.

730,714. PNEUMATIC APPARATUS FOR DENTISTS OR PHYSICIANS. Paul H. Stehley and James H. Hulings, Parsons, W. Va., assignors of one-third to Frazer P. Stehley, Keyser, W. Va. Filed Oct. 2, 1902. Serial No. 125,652.

A pneumatic dental apparatus for supplying either a liquid or a gas under pressure, consisting of a reservoir-kettle having a pendent depression extending from the top to near the bottom and open at the upper end, a detachable receptacle seated in said depression and having a stopper provided with a pendent tube extending to near the bottom, and an external stop-cock, pipe and nozzle communicating with said pendent tube, a second pipe connecting said detachable receptacle with the top of the kettle, an air-compressing device fixed to the kettle and discharging into the same, and two separate pipes, connecting with the kettle, one entering the top of the kettle to carry off air or gas and the other extending to near the bottom of the kettle to carry off water under the pressure of the supernatant air or gas.

730,715. TERMINAL FOR PNEUMATIC-DESPATCH TUBES. Ernest Steinbock, Chicago, Ill., assignor to National Pneumatic Service Company, Chicago, Ill., a Corporation of Illinois. Filed July 3, 1902. Serial No. 114,194.

730,791. GOVERNOR FOR PNEUMATIC PRESSURE. William H. Nightingale, Philadelphia, Pa., assignor to John E. Reyburn, Philadelphia, Pa. Filed Mar. 17, 1902. Serial No. 98,633.



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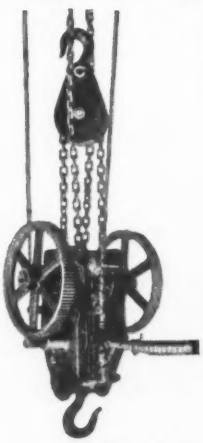

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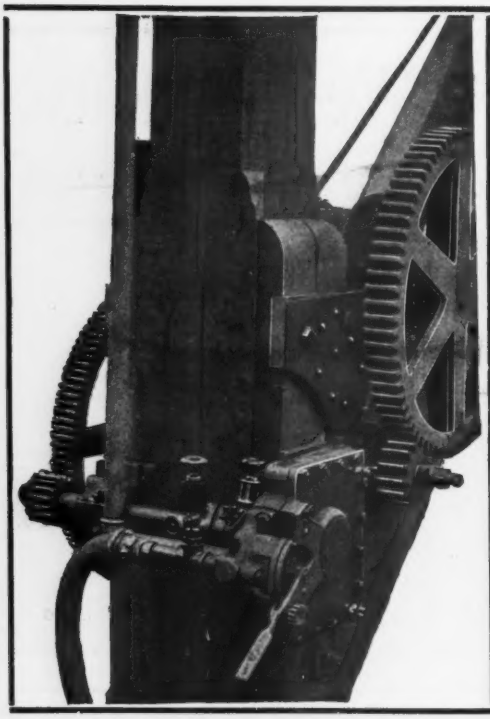

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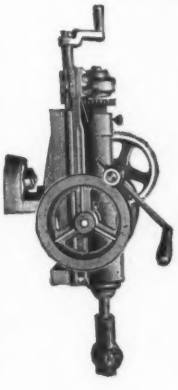

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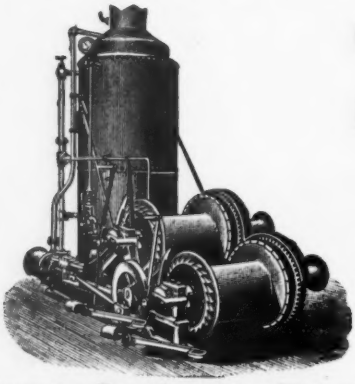

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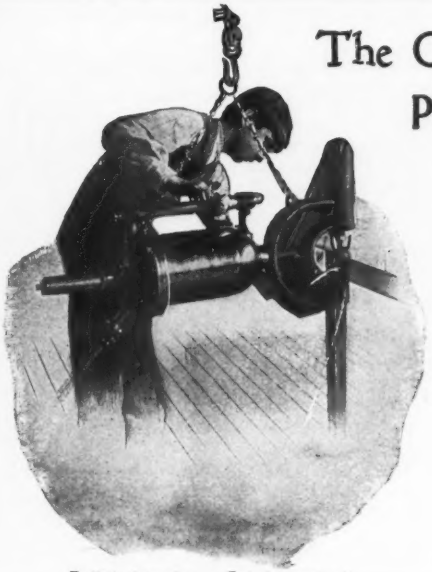

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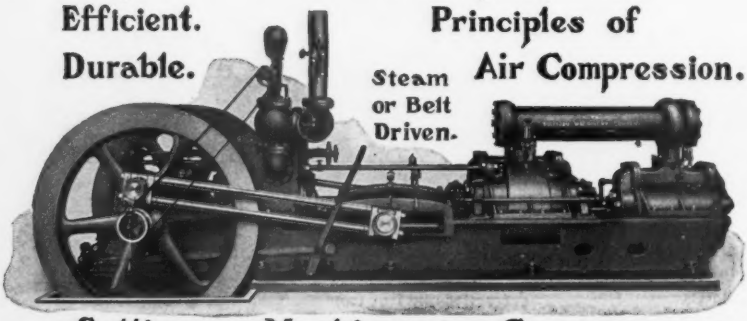

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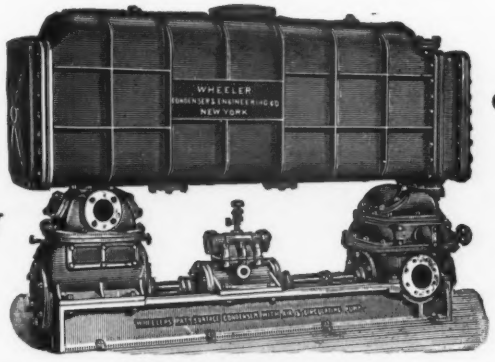

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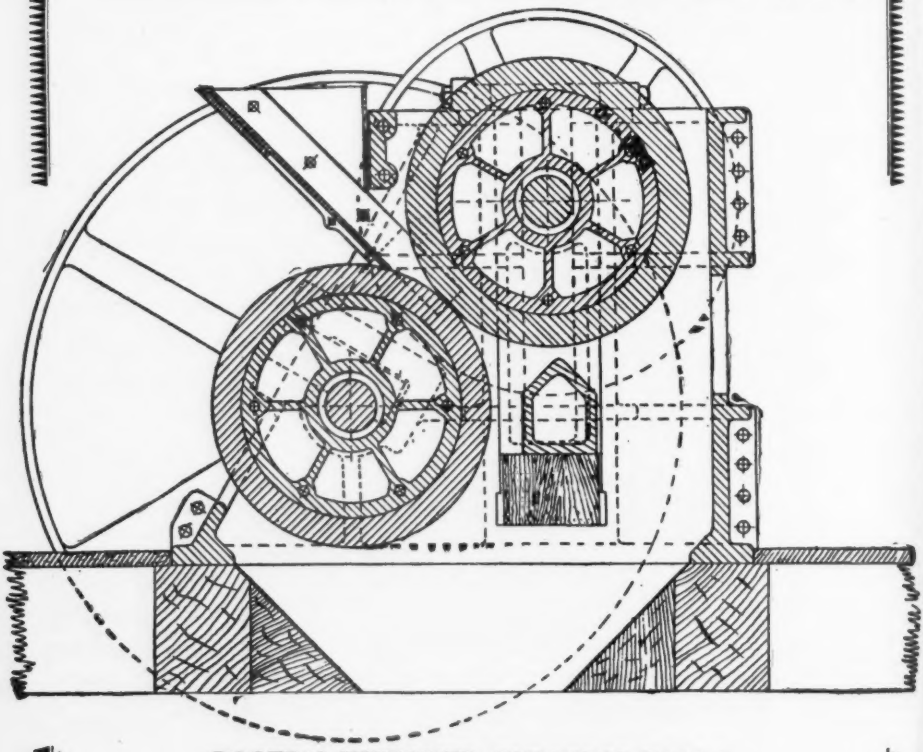

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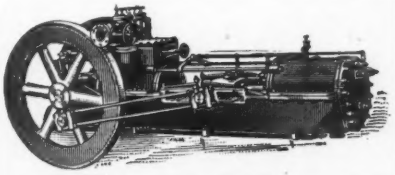

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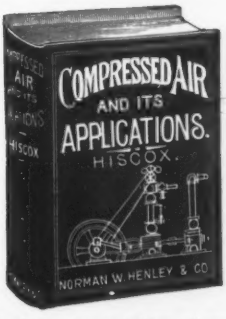

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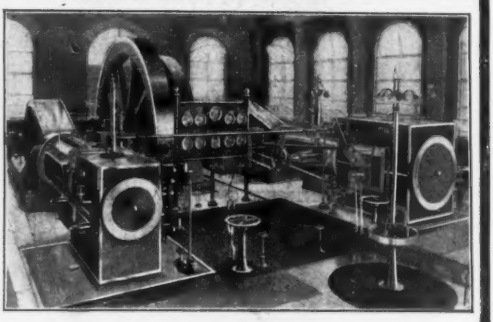

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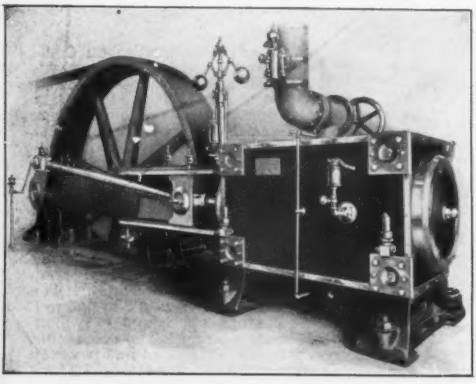

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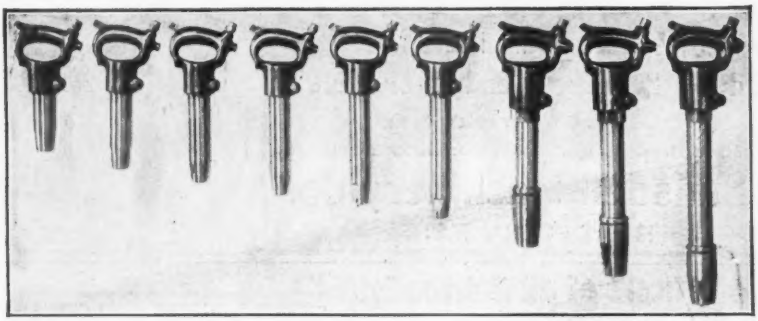

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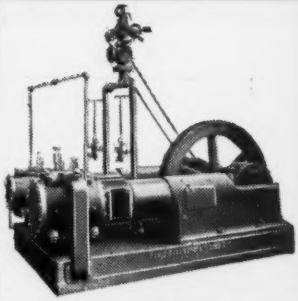

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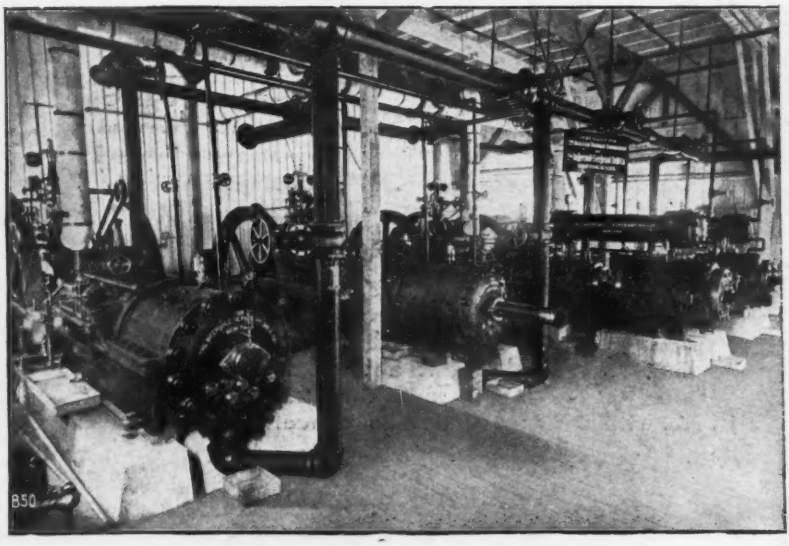

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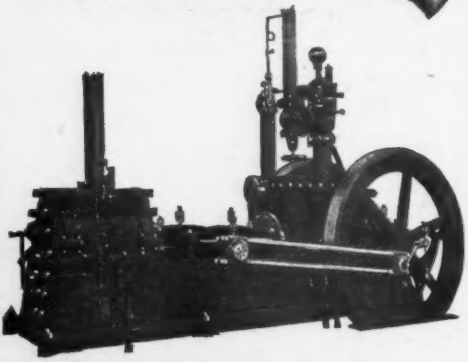

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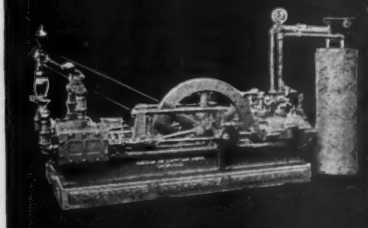

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